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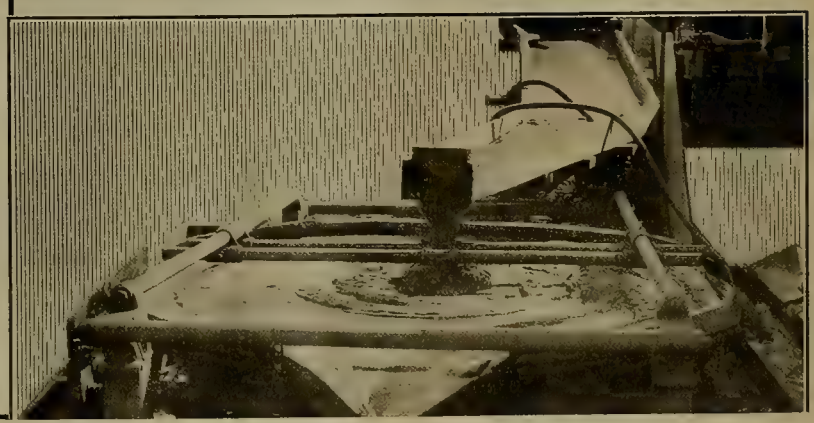

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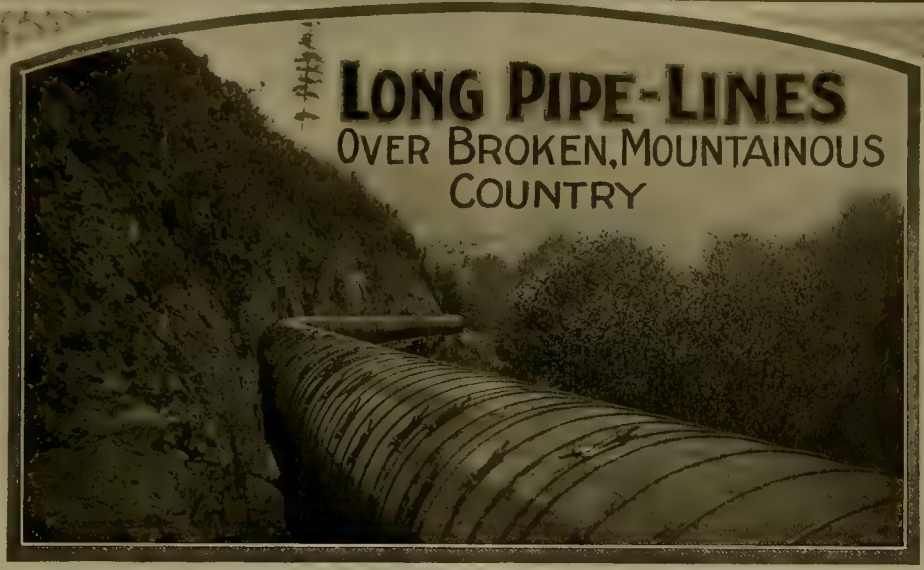

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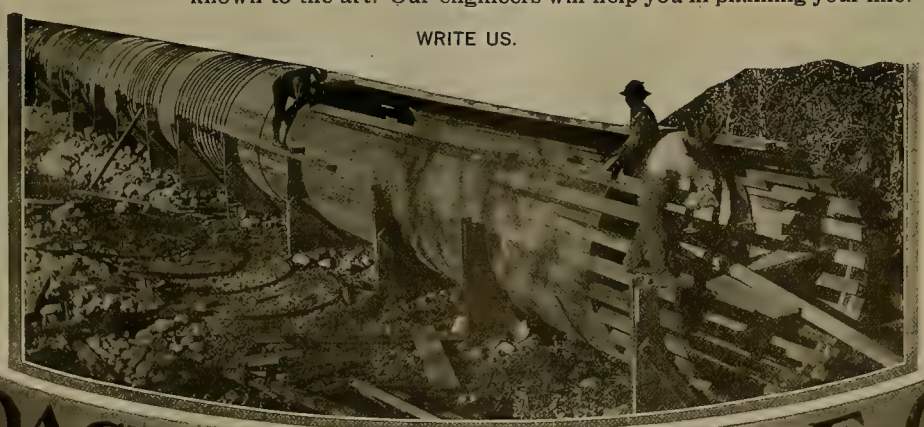

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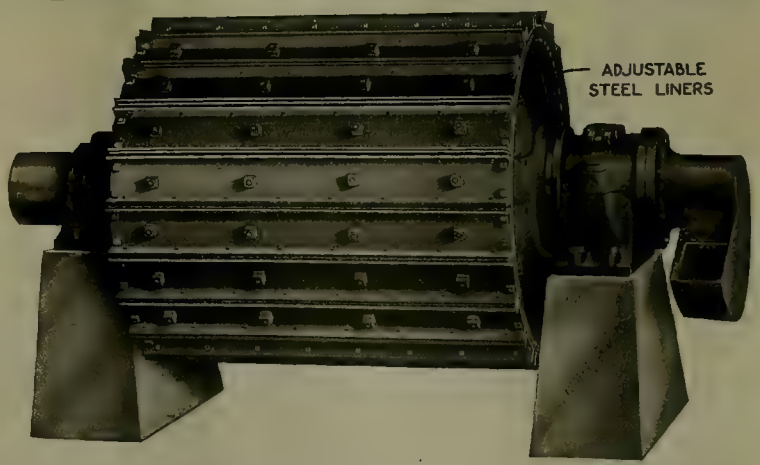

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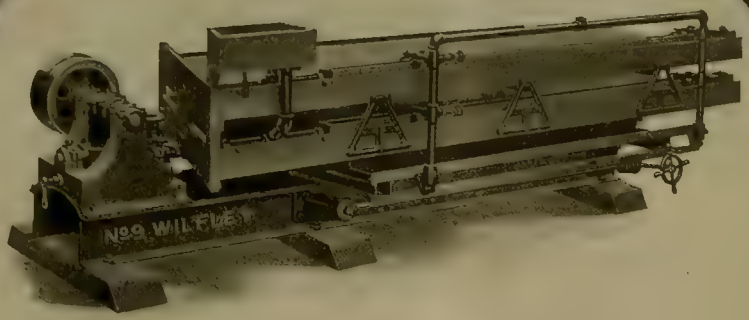

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W. H. Shockley.
Leonard S. Austin.
Gelasio Caetani.
Courtenay De Kalb.
F. Lynwood Garrison.
Charles Janin.
James F. Kemp.
F. H. Probert.
C. W. Purington.
Horace V. Winchell.

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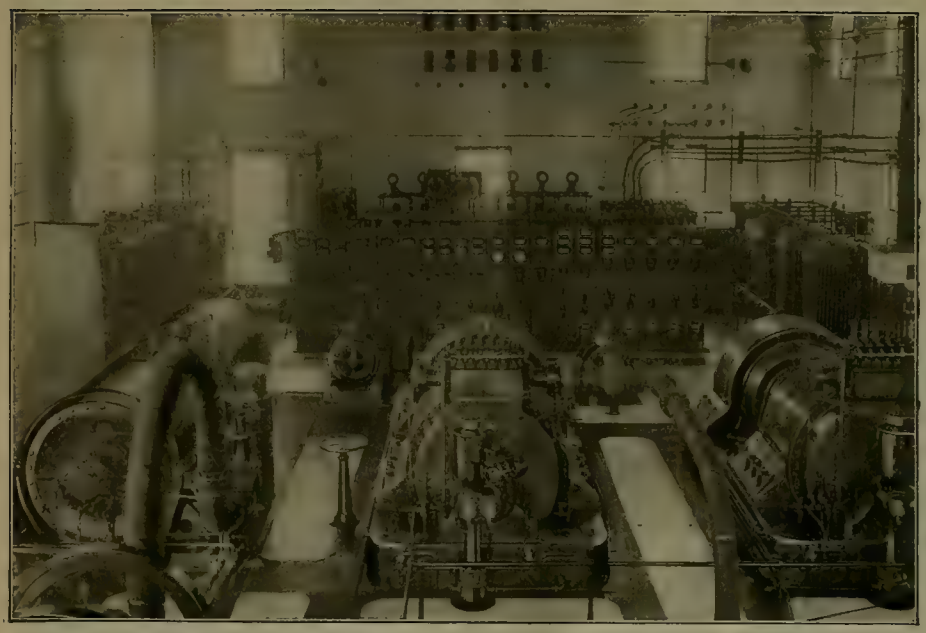

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EDITORIAL

T. A. RICKARD, Editor

USERS of the flotation process are advised not to be unduly disheartened by the Supreme Court decision in the Hyde case. We are informed that a way has been found for operating the process outside the limitations defined by the Court.

MISFIRES are discussed in this issue by Mr. Edward Higgins, lately of the U. S. Bureau of Mines, and Mr. Walter S. Weeks, of the University of California. To these gentlemen we are indebted for information of a directly practical kind.

READERS will note that the financial review of 1916 is written by Mr. Osmund Phillips, editor of *The Annalist,* which is the financial supplement to the *New York Times,* the leading newspaper of the United States. We are pleased to say that this review came to us in exchange for a review of mining in 1916 contributed to *The Annalist* by the editor of the Mining and Scientific Press.

LEGISLATION authorizing co-operative trade agreements is the subject of a letter from Mr. W. L. Saunders. With the purpose of such an agreement we are in hearty accord. As Mr. W. C. Redfield, the Secretary of Commerce, has said: "Economic alliances may come and go; tariff policies may change; but greater things will determine our place in the world. Combinations and anti-trust laws are relatively trivial. If we will waste, we cannot win."

WHILE the production of copper in the Lake Superior region in 1916 is estimated at 260,000,000 pounds, it is said that it would have been 40,000,000 pounds more if Sunday had not been set aside as a day of rest. This is a fallacious argument, for it assumes that the miner would have produced as much copper in the 52 days that were set aside as in an equivalent number of other days during the year. Our own experience has been that if a man works without a break, he is likely to lose his efficiency, even if he does not become incapacitated by illness.

GRINDING-MILLS are discussed by Mr. C. T. Van Winkle in this issue, with particular reference to the episode at the Inspiration mine. We believe our correspondent to be an independent engineer, not interested in the manufacture of any machine, and that is why we are glad to publish his letter. It is a rule of this paper not to publish matter emanating from the manufacturer, because he has the advertising pages at his disposal and because his view concerning the machines he makes are likely to be as prejudiced as his views concerning the machines that are made by his competitor. The opinions, and more particularly the experience, of any independent engineer or manager of mines in the use of any machine are welcome because they are likely to prove useful to others engaged in mining.

UNDER 'Discussion' we publish a courteous and disarming protest from a member of the Mining and Metallurgical Society of America against some comment recently appearing in these columns. In reply, we suggest that short of a general revision of the land laws by a competent commission, it is undesirable to repeal the extra-lateral right, now in force over so large a part of the mineral regions, and to confine immediate reform to the cancellation of 'discovery' as a preliminary to location, but not to patent. The second letter under 'Discussion' happens to refer to this very point. We have also received a letter from Mr. Horace V. Winchell on the subject, expressing strong disagreement with our views. His letter unfortunately arrived too late for inclusion in this issue.

ACCORDING to the best information, the British embargo on trade in copper, except under license from the Ministry of Munitions, is intended to prevent the use of the metal for non-essential purposes, such as the manufacture of brass bedsteads, household fixtures, and electric-light fittings, and to economize labor by diverting it from such non-essential work to other channels more immediately useful for the purposes of the War. It is stated also that an organization has been established for returning spent cartridges, for re-use or re-melting. In this and other ways great economies are being effected in the consumption of metals for munition purposes.

MEXICAN affairs at the beginning of 1917 are no more hopeful than a year ago. The Joint Commission has failed. We are told one day that Mexico has the moral capacity to become master of herself and the next we hear that Villa and his followers are capturing towns or destroying railways without serious opposition from the *de facto* government. Among mining men it is stated with a confidence fed probably by much wishing that the Carranza régime is on its last legs and that American intervention is at hand. Surely, they say, if Villa wins control of northern Mexico he will not be recognized by Washington, for he is an outlaw and a murderous raider. Meanwhile it is not ungenerous to suggest that President Wilson might look

upon the Mexican affair as more within the scope of his responsibility than the European conflict. The Mexican mess ought to be set right before the United States undertakes to act as peacemaker overseas.

REFERRING to the South African government's invitation for tenders to exploit mining claims in the Far East Rand, it is interesting to note that the Brakpan Mines Company made an offer for 1812 claims adjoining its present property, agreeing to spend £850,000 and to make a large increase in the existing milling plant. In addition to the 10% profit tax, the Brakpan company will pay 5% on any profit made during the next five years and thereafter a further royalty on a sliding scale, the minimum being 12½% per annum. Another tender, by the Central Mining group, was accepted on 650 claims, covering the Modderfontein farm, to be incorporated with the adjoining Cloverfield and Rand Klip properties, it being provided that the capital shall be raised to £1,200,000 and that a royalty of 10% shall be paid in addition to the 10% profit-tax. No American tenders were received. Meanwhile the State Mining Commission at Johannesburg is hearing evidence concerning the advisability of the State operating mines on the Rand on its own account.

IN reply to a Christmas cablegram to Mr. H. C. Hoover, informing him of the starting of the Belgian Kiddies fund, as announced in our issue of December 23, he replied as follows:

"Please convey to my American professional colleagues my gratitude for the very great personal compliment which I feel; in generous gifts to this work the Belgian Relief Commission has not only to be grateful to the American engineering profession for financial support, but also for the large body of men who have made the work possible; it has not been the work of any individual, but to the largest degree due to American engineers who have filled these ranks from the beginning and have brought to bear upon it not only their unique capacity for pioneer organization, commercial adaptability, and ability to overcome physical obstacles, but also the fineness of courage, devotion, and idealism which are the daily demands in this service and are to be found to such a degree in no other profession; we have had not only from the mining engineers, Honnold, Rickard, Shaler, Brown, Young, Thurston, Broderick, Fletcher, Smith, and Bain, but also from our brother engineering profession in America we include with equal pride the service of White, Holland, Hunsker, Crosby, Bates, Lucey, Connett, Chadbourne, Heinemann, Hulse, McCarter, Tuck, Gade, Gay, and Hunbert. It has been an engineer's job and has been done in an engineer's way; its recognition and support by our brother engineers is precious to us all."

We are informed that there has been a widespread response to the original circular, but only a few of the wealthier engineers have contributed as generously as had been hoped, the largest single contribution being for $10,000. It is hoped that some of the wealth so easily made during 1916 by those fortunate in their speculations may be diverted to the crying necessities of the little people in that downtrodden and most unhappy country that has become so unwillingly the scene of cruel warfare.

The New Year

The choice of a particular day to mark the start of another of the earth's flights on its orbit round the sun may be arbitrary, but the sense of an ending and of a beginning is felt by all of us. We turn a page; we close an account; we look forward to a new twelve months of life and endeavor. What 1916 has meant to the mining industry we attempt to tell on a following page; what it has meant to this professional paper we are glad to say in a few words. After two or three years of slackness the MINING AND SCIENTIFIC PRESS has re-taken a firm hold on the support of those actively engaged in mining. We are proud to say that 2615 new subscribers have been added during the year. This is an astonishing gain and affords no small measure of encouragement to those that have tried to make the paper useful. Many of the new subscribers are old friends who have returned to our support. To them we give the silent hand-shake of men that know each other. To the new members of our clientele we extend a hearty welcome, with the invitation to make use of us as a source of information or as a means of obtaining it from others. This paper is not the product of a machine and it is not run by a syndicate; we believe in the kind of journalism that is human and personal; if the editor is in control it is not to manage a slot-machine for advertisements but in order to be independent. It is so human to err that the least a man can do is not to add subserviency to the other factors that produce error. The aim of this paper is to promote the best interests of the mining industry and to serve the highest traditions of the mining profession. We make mistakes often—any outspoken critic is bound to do that—but we would like our readers to understand that an intelligent disagreement is always more welcome than a careless concurrence. This means that letters criticizing any expression of opinion or statement of fact appearing in our pages are given prompt publication. We are old enough to know—for were we not founded in 1860—that such letters are usually more interesting to our readers than those that endorse the editor's views. We hope that the 'Discussion' department will be used freely in 1917 as a means of creating sound opinion on matters important to the industry and to the profession. Therefore we repeat here what we have said often in conversation with the younger engineers: the writing occasionally of a technical article is an excellent method not only of emerging from the 'and others' and the 'also rans,' and of making mental acquaintance with men at a distance, but of crystallizing amorphous knowledge and of discovering what is not known. The first step in science is to separate what we know from what we do not know. Any

engineer that undertakes sincerely to describe a process or explain an ore deposit will learn more by the effort than anybody that reads what he has written. No mental discipline is more valuable to the technical man than the attempt to record his ideas or his experience in writing—for publication. We add the last two words because the consciousness of possible criticism is a necessary spur to careful performance. However, the writer, particularly if he be inexperienced, should remember that he has a friend at court in the editor, who stands between the writer and the reader so as to make the relationship pleasant for both. We also invite items of mining or metallurgical news. Upon our friends in the field we depend largely for authentic information concerning current developments. The sifting of such news is beneficial to all concerned. Only those behind the scenes can know how difficult it is to obtain accurate data concerning the progress of events in a speculative industry. Another thing for which we ask is friendly criticism—constructive, of course, and helpful, but none the less frank. In a sense every subscriber is a shareholder, for the opinion of the reader of such a paper as this is of more moment than that of a shareholder that is not a reader. Please assume that we aim to be of maximum usefulness; that we want to be of service to as many as possible and of disservice to as few as possible; that we aim to be interesting while being also truthful—this is our policy. For such plain speaking we offer no apology. Straight talk is best among friends. In the year ahead of us there will be many problems to face; the effect of the War and the anticipation of Peace will alike cause market perturbations; the relation of labor to capital is likely to undergo painful adjustment; the speculation in mining shares will be so intense as to stimulate illegitimate methods, both of financial promotion and of professional participation; the year 1917 is going to test character. May it prove that the mining engineer is not only a technician and a business-man but a citizen and a gentleman.

Minority Rights

A suit has been brought by Dodge Bros., as minority shareholders in the Ford Motor Company, to compel Mr. Henry Ford to distribute a reasonable portion of the company's $55,000,000 surplus in dividends and to restrain him from investing or otherwise using the company's funds in ways that do not meet with the approval of the plaintiff shareholders. This action has aroused keen interest and the injunction granted by the court of first resort, which ordered a further hearing on the merits of the case, is likely to accentuate interest in the matter. It comes within our purview because Mr. Ford proposed to use the accumulated cash in building a smelter on the river Rouge near Detroit. Two questions are involved: (1) Is the diversion of the money for this purpose an abuse of the usual discretion allowed to directors? And (2) does such business come under the charter rights of the defendant corporation? The Dodge brothers maintain that Ford's policy is to benefit humanity rather than to make money, having made much more than he needs. The controversy, it seems to us, narrows itself to the question whether Ford is acting as a trustee for all the shareholders or doing simply what pleases the largest shareholder—himself? Problems of this kind arise frequently in the administration of mining companies and most of us can readily recall instances in which a company dominated by an individual or by a small group has been administered to suit his or their plans in directions outside those for which the company was organized and in schemes alien to the purpose for which its capital was subscribed by the shareholders. In such matters the law affords but little protection to the minority shareholder, because any effort to assert himself involves costly litigation the outcome of which is doubtful owing to the ease with which financiers can hide their tracks. Public opinion is the main deterrent, even if it be feeble in its impact upon the prestidigitateurs of finance. In England the Companies Acts give protection to the lonesome shareholder but it must be confessed that the check on *finukerij,* as they call it on the Rand, is not enough to prevent the unscrupulous promoter or even the more considerate 'big house' from 'putting it over' the public. Laws derive their force from public opinon. In no sphere of industrial activity is it so necessary as in mining to stimulate and support a high standard of decency in matters that affect the responsibility of directors to the owners—that is, the shareholders—of property.

The Small Miner in 1916

The year 1916 will be long remembered by the small mine-owner and operator as a period of unusual prosperity, for it has been a year of rapid wealth-getting to many of these as well as to the greater concerns whose output runs into the millions, and whose worries and responsibilities are correspondingly greater. It has been a year teeming with unexpected possibilities, and many there are who saw in these new opportunities the nearest approach they had even known of that elusive fortune which had been sought eagerly and long. In numerous instances the vision of the money goddess came true; in many others it vanished, as before, and with it much of the hope that had been quickly lifted from the depths, for the market fell and opportunity was gone. The sudden and unprecedented rise in quicksilver, the great demand for tungsten, antimony, chromic iron, magnesite, and manganese urged the small mine-owner, lessee, and operator as he had never been stimulated before to produce the minerals and metals for which the market called urgently and ever in greater amount, with a consequent daily increasing price. Hundreds of men—brokers, merchants, and others, most of whom had never seen a mine—plunged boldly into the swirling stream and in most instances they, or their clients—usually the latter—were engulfed in the maelstrom of speculation from which some escaped, poorer if not wiser men.

One noticeable feature of this modern boom in mines

was the nonchalance with which men of the Rufus J. Wallingford type offered for sale the mining property of others without the slightest authority from anyone, to say nothing of the owner. One mine, a quicksilver property of merit, was offered about San Francisco by no less than seven different men and their numerous assiduous satellites, each of whom claimed to hold an exclusive option to purchase the mine in question, though no option on the property had been given by the owner to anyone. The price asked for this property ranged from $40,000 to $240,000.

The demand for quicksilver was so unexpected and so insistent that the price rose rapidly from $32 per flask late in the fall of 1915, to $300 a few weeks later. Was there unusual activity in quicksilver mining? There was, and it was prompt, vigorous and—in some instances—disastrous. However, the rapidity with which the demand was satisfied 'knocked the props' from under the market, and the price came down even more rapidly than it had risen. Today the quicksilver industry of California is moving along quietly and satisfactorily, and in a dignified manner, with the price of the metal at somewhat over a dollar per pound. Scarcely less stirring was the effect of the rapidly soaring price for tungsten ores. Two or three years ago the owner of a tungsten property, either large or small, considered himself fortunate if he could dispose of his 60% ore at $450 per ton, but during 1916 the price vaulted to $85 per unit—a price that promptly brought even cabinet specimens into the market at $4 per pound. It also stimulated prospectors and miners to use their utmost endeavor to grasp at least a little part of the millions of dollars that seemed to be fluttering in the air within the easy reach of any who would make an effort. But tungsten, like quicksilver, soon glutted the market, and it was this, together with the more important fact that Eastern buyers evidently had some sort of understanding, that resulted in the downfall of the rickety price of WO_3, and put a sudden stop to the further extension of all but the absolutely legitimate development of the industry. Added to the depreciated market was the further deterrent of the disappointing development of a number of unusually promising prospects—rich at the surface, but quickly petering in depth. So, tungsten, like quicksilver, is moving along soberly at about $20 per unit but not without hope for a somewhat better price in the near future—peace or no peace. Chrome, manganese, and magnesite shared in the general good fortune of the year, but in a more moderate degree than quicksilver or tungsten.

There was one peculiar phase of copper mining that was without precedent in a time of unusual activity in the demand for and production of the metal. This was the inability of the small copper-mine owner, or lessee, to sell his ore. While the great copper producers were being worked under ever increasing pressure, the smelting facilities were inadequate to treat the enormous tonnage of ore offered. Much of the ore was being smelted under contract at the custom reduction works and as the capacity of the furnaces was taxed to the utmost, the small producer could not be accommodated; so he had to stand aside and see the big operators enjoying an unprecedented prosperity in which he, the small producer, had no share. But the working miner—the man that is the mainstay, after all, of mining, whether it be a little property, employing only two or three men, or one of the great enterprises that numbers its employees by thousands—has benefited directly by the expansion of mining enterprise in 1916, for there are few places where wages have not been increased from 10 to 30%. Even the managements of gold mines, which as a whole were not benefited by the unusual activity of the year, but on the other hand were adversely affected because of the rise in price of supplies, voluntarily increased the wages of workmen, perhaps not so much from philanthropic motives as from a desire to discourage their best men from migrating to the copper and zinc mines. Thus wages were raised to the direct advantage of the miner, at a time when he needed it, to compensate for the higher cost of living.

Metal Mining in 1916

The year now near its close has been abnormal. Mining has been conducted under the stimulus of a feverish market, the future of which no man can foresee.

This review does not concern itself with ferrous mining, which is a subject apart, yet it is proper to refer to the growth of a basic industry. The production of pig-iron in the United States during 1916 is estimated at 40,000,000 tons, an increase of 11,000,000 tons as compared with that of the preceding year. This country now produces more than half the pig-iron of the world—a fact that may prove more important in the long run than our present hoard of gold. Long ago Solon told Croesus, the king of Lydia: "Gold will never save you; if your neighbor has more iron than you, he'll conquer you and take your gold." He referred to weapons, and in these later days iron may represent munitions, as well as the strong foundation of peaceful industry. We are producing annually $800,000,000 worth of iron as compared with a little less than $100,000,000 worth of gold. Our production of gold in 1916 may have increased slightly, but the value of the gold dug out of the earth is insignificant compared with that imported by us in exchange for commodities and securities. We have now over two and a half billion dollars of gold in this country, and if our foreign trade continues for another year at the existing rate we shall have four billions, or half of all the visible supply of gold, outside the arts, in the world. All the gold extant could be contained in a 28-ft. cube. The world's annual output is only $450,000,000, and two-thirds of it is mined under the British flag.

Owing to the consumption of the base metals in the manufacture of munitions there has been a great expansion in the mining of copper, lead, and zinc. The vagaries of the market can be summarized as follows, in cents per pound of metal:

	Dec. 1, 1913	Dec. 1, 1915	Dec. 1, 1916	1916
Copper	14.25	19.75	34	Early in May, 29.5; in July down to 25
Zinc	5	18.12	13.25	Down to 8.37 in August; rising since
Lead	4	5.75	7.25	Up to 8 in March; sagging to 6 in August

The 'peace scare' just before Christmas caused a drop in the prices of copper and zinc, to 31 and 9.75c. respectively, as if to warn us of what may happen if hostilities cease in Europe. The rise in the quotation for lead, to 7.50c., is less significant, as it is the price fixed arbitrarily by the American Smelting & Refining Company.

Copper, owing to the big purchases made by the Allied governments, has had a spectacular rise wholly unforeseen a year ago. At the present time the production of this country is sold seven months ahead; in other words, the copper to be produced by the United States during the first half of 1917 is sold already, at prices ranging from 24 to 32 cents. Production has been pushed by all the great mines so as to make the most of the extraordinary market, and it became a question early in 1916 whether the refinery capacity could keep pace with the expanding output of blister copper. That has been nearly done, so that today the American refineries can treat 1,200,000 tons per annum, which is about the rate of gross production anticipated within six months. In 1913 the world's production of copper was 1,104,500 short tons, of which the United States contributed 614,400 tons. Therefore our production will shortly be double what it was three years ago. Our export for several years before the War was 350,000 tons, of which Germany took 100,000 tons, increasing to 153,000 tons in 1913, when preparations for War were being made. The market is now in an unhealthy condition and is causing big gambling in the shares of copper-mining companies, the quotations for which have shown tremendous appreciation:

	July 30, 1914	Nov. 18, 1916	Dec. 23, 1916
Anaconda	$25	$104⅞	$81⅜
Inspiration	15	74¾	55¾
Utah	46	130	98½
Nevada Con.	10¼	33⅞	23¼
Miami	17½	48⅝	37½
Ray	16¼	36⅝	26⅛
Chino	32	74	53

The heavy drop that followed the 'peace scare' is indicated by the quotations on December 23.

Making allowance for pre-War contracts, the mining companies have obtained an average of about 25 cents for their metal in 1916, as compared with 15¼ cents in 1913, so that their profits have been enormous, but, in so far as the present speculation in shares is based on the expectation of the persistence of the present price of copper, the position is precarious. In September Great Britain, for herself and her allies, purchased—in one transaction—the larger part of the entire American production of copper to be made during the first half of 1917. The deal involved 480,000,000 pounds at 25½ cents. Since then the price has risen 9 cents, to 34½, so that it is quite reasonable to surmise that part of this purchase may be re-sold on our market, in anticipation of lower quotations. Speculation in copper has spread from the bucket-shop to the Treasury.

Zinc rose to 27 cents per pound in 1915, and was on the decline at the beginning of 1916. This relapse continued until the price had fallen to 8.37 cents in August, but since then the demand for 'spelter,' as it is known in the metal trade, has been in sympathy with the rise in copper, with which it is alloyed to make the brass used in munitions and other warlike apparatus. Therefore the market has improved and stands now at a price 120% higher than in the days before the War. The almost complete cessation of production in Australia during 1914 and 1915 caused a big drain on the American supply, and accounts for the excited market in the second year of the War; since then the British have consolidated their position and made arrangements for a large domestic production the full effect of which will be felt when the world is at peace once more. Australia produces just the tonnage of zinc that Great Britain consumes normally. Since 1914 the number of retorts in action in the United States has been nearly doubled, the increase of zinc output being equal to the whole American production in 1913.

Lead also has had an eventful record, stimulated by the use of the metal in shrapnel and other munitions. Normally we produce only about 10% more than we consume, so that the cessation of the War demand threatens a big drop. However, any such suspension of demand for the metals is dependent on the course of events that nobody can foresee. Whether peace ensues in six months or two years is not predicable; therefore the business of production rests today on an extremely insecure basis. While the drop in prices may not take us back to the pre-War quotations, it is to be noted that part of the profit to be obtained by an incomplete recession to the basis of July 1914 will be absorbed in the higher cost of production.

This is an important factor. While the normal cost of producing copper, for example, in the United States may have been 10 cents per pound before the War, it is safe to say that it is 13 cents now, and it will go higher as the present conditions persist or become worse. Not only is the expenditure for labor, supplies, and machinery rising steadily in the effort to distribute the mine-owner's abnormal profit among his various coadjutors, but the richest and most accessible orebodies are being exploited in a hurry in order to take advantage of the extraordinary market. This means not only the exhaustion of the better grade of ore, but such a serious deterioration in the physical welfare of the mines as will require the expenditure of time and money in order to restore them to normal efficiency. In the zinc business, it is estimated that the cost of production, which before

the War was close to the market-price of 5 cents, is now about 7 cents per pound, owing to the concomitant rise in labor and materials. This increase also threatens to be accentuated for reasons similar to those recited as affecting the winning of copper.

Some of the secondary metals have shown fluctuations even more violent than copper or zinc. The prices given herewith represent the quotation per unit, that is, 1% per ton, or 20 pounds, at New York:

	Dec. 1, 1913	Dec. 1, 1915	1916	Dec. 1, 1916
Antimony (Sb)	$2.00	$8.00	In March, $9	$2.80
Tungsten (WO_3)	7.00	45.00	End of February, $85 Down to $30 in July	18.00
Molybdenite (MoS_2)	4.50	30.00	End of January, $28 Middle of June, $22	36.00

Tungsten is quoted in terms of a concentrate containing 60% tungstic oxide and molybdenite in terms of 90% molybdic sulphide.

Antimony has been quiet as compared with 1915, when the price rose to 40 cents per pound, or $8 per unit, in December. This rise continued into 1916, culminating at 45 cents in March, when the effect of shipments from China and Japan, added to the quick increase in our own domestic production, caused a collapse. At the end of June the price was 20 cents, the decline continuing to the present quotation of about 13 cents per pound. Antimony is used in making 'hard lead' for shrapnel bullets and is therefore a 'war baby,' but of late shrapnel has given way to high-explosive shells, lessening the demand. This metal is imported so cheaply and of such good quality from China that the mining of it in this country has been discouraged. The rise in price led to the reopening of small mines in California, Alaska, Idaho, and Nevada, and the operation of small smelters at Los Angeles, San Francisco, and Seattle. It is possible that the revival of prospecting for antimony may lead to the discovery of deposits large enough and of methods efficient enough to lay the foundations of a new industry.

The interruption to shipments from abroad has created a demand for the special metals used in steel-making, and has stimulated the search for the minerals containing them. There has been a lively market for tungsten, molybdenum, manganese, and chromium. Whether the search for such ores will have enduring results is an interesting question. It gave a hectic flush to 1916. Tungsten, which is used to make the high-speed tool-steel required in the munition factories, has had a career even more exciting than that of antimony. From a pre-War price of $6.50 per unit, the quotation rose in February 1916 to $85 per unit, or $4.25 per pound. This was due to wild speculation, for the price dropped quickly to about $70, and thereafter began to decline until in July it had reached $30, where, however, it did not stay, falling to $17 in September, since when the market has been fairly firm. Molybdenum, another ingredient in the hardening of steel, has advanced steadily, its cheapness being measured by the fact that a given quantity of it will harden twice as much steel as the same quantity of tungsten. Existing prices reflect this ratio of efficiency.

Two other metals remain to be reviewed:

	Dec. 1, 1913	Dec. 1, 1915	Dec. 1, 1916
Silver, per ounce	57.76c.	56.12c.	75⅛c.
Mercury, per flask	$40	$105	$80

Silver was not affected by the War until it became evident that this precious metal would be required increasingly for subsidiary coinage and to replace the gold being withdrawn from circulation. The curtailment of production in Mexico might have been a further factor if the increased output of silver as a by-product in the mining of copper and other base metals had not more than compensated.

In the middle of February quicksilver rose to $300 per flask of 75 pounds, but this quotation was momentary, a sharp break being followed by a decline so that in May the price had receded to $100, and in June to $68, since when there has been a slight recovery. Undoubtedly an attempt was made to corner the supply, but it failed ignominiously when the British government lifted the embargo on exports from Europe, admitting shipments to New York from Spain and Italy. Moreover, the stocks of quicksilver held at silver mines in Mexico that had substituted cyanidation for amalgamation came upon the market as soon as the price was trebled, and sundry gold-mining companies likewise took advantage of the abnormal price, while others exercised the greatest economy in its use. The War, of course, played a part both in the rise and fall. Mercury is used in making fulminate for detonating caps, a supply of which is manufactured by the Du Pont works for the Allies. When the price of quicksilver soared prohibitively in this country, the British government called upon the Rothschilds, who control the European production, to correct the artificial condition created by American speculators. The lesson was salutary. Since then nobody has cared to gamble. This is another example of the manner in which the metal markets are subject to the exigencies of the War, and to the action of individual Governments endeavoring to facilitate their own warlike operations. After all, the normal production of quicksilver in the United States—20,000 flasks—is so small that any increase in production is felt at once.

A rise in the price of a metal or a mineral to ten times its normal price gives economic value to the discards of earlier times. When quicksilver and tungsten were being kited there was a great rush to work old dumps and to extract the filling of old stopes all over the West. The tungsten 'boom' in Colorado was typical. There, in Boulder county particularly, the ferberite, or iron tung-

state, that had been cursed by the mill-man because it interfered with the amalgamation and concentration of gold and silver ores, and that had been thrown aside, without scrutiny, was put into sacks by enterprising collectors and sold at a handsome profit. Idle mines became valuable for their abandoned dumps or were reopened for the tungsten ore yet to be mined. Small boys made an easy gain from the pickings, and 'high-grading,' the miner's euphemism for petty larceny, became fashionable. The aftermath of all this was a recognition of the tungsten minerals, a successful designing of methods for concentrating them in the mill, and such a study of the economic geology of the district as will furnish guidance for further exploration. In California the search for scheelite, the tungstate of lime, received a similar stimulus. It is a notable fact that the biggest dividends paid by any metal mine in California during 1916 came from a tungsten property, the Atolia, in San Bernardino county. This enterprise luckily was a going concern when the 'boom' began, the mine having been worked profitably for several years, so that it was in a position to make the most of a favorable market. The lessees on the property rushed their production and the company built a new mill. Here also theft became rampant. It is even asserted that representatives of the steel-making manufacturers sent agents to Atolia to buy 'high-grade' or stolen ore.

When quicksilver rose suddenly to $300 per flask, as against the $40 to which the price had sagged in former years, the haste to find it led to strange doings. California, Nevada, and Texas enjoyed the excitement. Old furnaces were dismantled for the liquid metal with which the brick was soaked, old dumps were sorted and marketed, abandoned workings were penetrated. In some instances hasty concentrating apparatus was devised and in others the new flotation process was tried. Although the collapse of the market came so quickly several metallurgical improvements can be chronicled among the sequelæ of the boom, such as the introduction of the Cottrell tube for condensing the sublimate and the application of flotation to cinnabar. Several mines changed hands, and with them considerable sums of money, but most of these have been closed already. The flurry has attracted attention to the nimble metal and has led to sundry scientific investigations into the quicksilver deposits of the coastal region, so that information has been collected that will be utilized in fresh exploratory work.

The foregoing paragraph suggests that the whole story of mining in 1916 is not told by statistics, whether of the metal-market or of the stock-exchange. The stimulus to the search for ore, the re-opening of old mines, and the invention of new methods are consequences that will outlive the ephemeral results. The development of a copper mine, more particularly the large-scale operation on which the industry increasingly depends, is not the work of a day or even a year. The high quotation for the metal has led to the intensified exploitation of existing mines rather than the starting of new ones, because the more sagacious among men realize that the abnormal market may not last long enough to bring a new enterprise to fruition. Nevertheless conditions have favored increase of energy in developing mines recently started and in exploring new ground belonging to the older properties. One of the striking episodes of the year was the uncovering of an extraordinary deposit of rich ore in the United Verde Extension mine, at Jerome, Arizona. The first company to work this prospect was organized in 1894 and was re-organized in 1902 and again in 1912. In 1913 the mine had about 5000 feet of underground openings and showed a little ore on the 800-ft. level. This ore contained 2% copper, with 1 oz. silver and 3 dwt. gold per ton. At the end of 1915 a big bonanza was uncovered on the 1400-ft. level. Early in 1916 this orebody was proved to be a mass 250 ft. long, and equally wide, of 17½% copper ore. Shares that had sold at 50 cents in 1915 rose to $46, making many men wealthy. For example a well-known engineer bought $15,000 worth of stock, and within twelve months he emerged a millionaire. This is one of the authentic romances of mining, and it would be wholly delightful if it were not being used now as a lure for the simple-minded speculator.

Another notable episode was the intensified exploitation, or 'gutting,' of the wonderful mass of ore in the Kennecott mine, in Alaska. This was removed and shipped from Cordova to Tacoma at the rate of 5000 tons per month; indeed the supply exceeded the capacity of the Tacoma smelter, so that shipments of crude ore from this mine were passed to the Garfield smelter, in Utah. The output for 1916 must have been about 55,000 tons of metal. The cost is said to have been only 5 cents per pound, for much of the ore assayed 60%, which would mean that a ton of such ore contained 1200 pounds, or $300 worth of metal, yielding a profit of $240. The earnings of the Kennecott company were stated to be $1,000,000 per month. This excused the financial legerdemain called a 'merger' whereby the Kennecott Copper Company was consolidated with the Braden Copper Company and sundry holdings of the Guggenheim Exploration Company in other copper mines. Statements have been made that the Kennecott has a five-years supply of ore, and the public is allowed to infer that it will be of the same extraordinary richness.

The breaking and removal of ore is only half the work of 'mining,' which must be supplemented by the extraction of the valuable metals, namely, metallurgy. In this department the year 1916 has seen at least two far-reaching developments: the flotation of oxidized ores and the electrolytic refining of zinc. The flotation process may be defined as a method of concentration in which froth is made by the introduction of air into water modified by oil or some other contaminant that lowers the surface tension so as to cause the bubbles constituting the froth to last long enough to float the particles of metallic sulphides in a pulverized ore. The wide application of this process is contemporaneous with the War, for it had made but little headway in the United States up to August 1914. During 1915 a rapid extension of flotation took place and in 1916 a still greater advance was

recorded. The Inspiration and Anaconda companies are each treating from 15,000 to 18,000 tons of copper ore daily by this process, and it is safe to say that 30,000,000 tons of ore per annum is being concentrated by flotation in the United States at the present time. This is truly a 'revolution' in metallurgy, for the scope of the process is proving as much wider than that of cyanidation as cyanidation was more widely applicable than chlorination. Since the introduction of the cyanide process on the Witwatersrand there has been nothing so epoch-making as the application of the frothing process to the copper ores of our West. Moreover, the same process has been used successfully on silver ore in Mexico, on gold ore in Nevada, on zinc ore in Montana and New Mexico, on lead ore in Missouri and Idaho. The process succeeds exactly where water concentration failed, namely, in saving the flakey slime inevitably formed when sulphides of highly developed cleavage are crushed minutely. It is exercising a tremendous influence on mining, not only in aiding the profitable exploitation of low-grade ores but in enabling the metallurgist to beneficiate the zinc that is associated with the other metals and that formerly was regarded as of negative value because it hindered the separation of those other metals to such a degree as to warrant the smelters in imposing a penalty, which was graduated in accordance with the proportion of zinc present in the copper, lead, or precious-metal ore, as the case might be. The amount of oil or other modifying agent has been reduced in quantity, to a fraction of a pound in some mills, until it has become a minor item of cost. At the same time the improvements in fine-grinding machines have expedited the preparation of the ore so as to permit of further economy. The cost of concentrating a low-grade copper ore, on a large scale, by flotation, including the crushing and grinding, has been diminished to 45 cents per ton. The product is a concentrate, of which so much is being made as to cause a decided change in copper smelting, for it necessitates the increased use of the reverberatory furnace and additional emphasis on the roaster equipment. This development in flotation is to be credited in part to 1915, but the successful treatment of oxidized ore is a feature of 1916. Previously it had been supposed that sulphide ores alone were amenable to flotation and that oxidized ores were not only recalcitrant to the process but that they interfered with the successful recovery of the sulphide portion of the mill-feed. It has been demonstrated in the course of 1916 that the oxidized ores of copper and lead can be treated by flotation. This is done by sulphidizing, or coating with an artificial sulphide, so as to render the oxidized mineral amenable to flotation.

Another metallurgical development that has come to fruition in 1916 is the extraction of zinc by the electrolytic process. This had been done previously on a small scale in Ontario and in California, but the completion of big plants at Great Falls in Montana and at Trail in British Columbia, besides another in course of construction at Garfield, in Utah, has made the process an important factor in both the metallurgy and the trade of zinc. The plant at Great Falls, work on which was begun on December 13, 1915, is now producing 100 tons of spelter per day; that at Trail, for which ground was broken in October 1915, is producing 70 tons daily. In both establishments the process that is used depends upon the oxidation of the sulphide by careful roasting, the leaching of the oxide and sulphate of zinc in a sulphuric acid solution, the oxidation and precipitation of the ferrous oxide by manganese di-oxide, and the purification of the solution—removing its copper and cadmium—by means of metallic zinc, and finally the electrolysis of the purified solution in the presence of an aluminum cathode and a lead anode, yielding a metal of 99.98% purity. The cheapness of the process depends upon the cost of the electricity, which at Great Falls is obtained from the Missouri river and at Trail is drawn from the Columbia river. Where electrical energy is obtainable for $15 to $20 per horse-power year, on a 100% load-factor, this metallurgic method should prove economical as well as highly efficient. It promises to supersede the old retort method of Belgium and Silesia, and to provide the trade with a spelter of exceptional purity. It is important to note also that the electrolytic process brings low-grade ore within the economic limit. Whereas the retort-smelters afforded a market only for a 50 to 55% concentrate, the Great Falls plant is purchasing concentrates containing as little as 35% zinc. Indeed, the low limit is 30%, which means about half zinc-blende, the mineral averaging 67% zinc when pure. Zinc is a metal that is usually found in close association with other metals; formerly it was so detrimental to the treatment of complex ores that it was heavily penalized by the smelters and other ore-buyers. The customer had to pay 50 cents per unit on an ore containing over 5% zinc. Now the zinc in such an ore is separated and treated so as to yield a valuable by-product. This will tend to stimulate the production of metal, of which there will be an over-supply, followed inevitably by a decline in price. The galvanized trade will not be taxed as heavily as it is now by the high price of zinc and only those that can mine and smelt it most economically will be able to survive the growing competition.

The economic conditions now prevailing are not favorable to gold mining, except in so far as the accumulation of capital leads to new enterprise. The value of gold, although fixed by convention, has depreciated considerably of late, as proved by the fact that a given weight of it will buy 30% less of the principal commodities than a year ago. The cost of supplies and machinery, more particularly the use of man, the essential machine, has risen 25 to 33%. A higher rate of wages has been forced upon the managements of gold mines because the base-metal mining companies have granted a raise to their employees and also because the increasing cost of living leaves the workman a diminishing margin on the safe side. Labor troubles have been few, mainly because sagacious managers have anticipated the inevitable demand, but re-adjustment after the War is sure to involve friction and is anticipated with misgiving.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Mining Law Revision

The Editor:

Sir—Your criticism, in the issue of December 9, of the procedure of the Mining and Metallurgical Society of America in respect to the work that it has done and is doing in reference to a revision of the United States land laws as they affect mining locations, hardly seems to the writer to be in accord with the facts or with your well-known fairness in discussing matters relating to the mining profession.

Attempted ridicule suggests the lack of potent argument, and your editorial would be taken more seriously and be more useful if you would point out wherein the M. & M. Society was in error and in what manner its object, if that object is meritorious, could better be attained.

You must admit that the coal, oil, and metal miners have had some serious and just complaints, that the prospector has felt that his lot was becoming a hard one and that every mining society and organization in the country has expressed itself as believing that some alterations would be advisable.

The idea that something was wrong did not originate in the M. & M. Society nor do any of its members think so or feel that they know all of the remedies to be applied. The members know that they form but a very small part of a very large profession, but they feel that they can and should help to the best of their ability.

The M. & M. Society, realizing that the questions are very broad, affecting thousands of the citizens of the United States, understood thoroughly the futility of any organization, large or small, attempting to formulate a new code that would be acceptable to the majority of the people interested in the business. Joining with other organizations whose combined membership was several thousand, and without doubt fairly representative, it urged to the utmost the appointment of a commission, competent to take all evidence that could possibly be submitted, and competent to advise Congress what, if any, alterations should be made.

Whether the commission idea is right or wrong, it was supported by every mining organization in the country that ventured an opinion on mining law, but Congress denied the request and failing to realize the complexity and breadth of the subject advised the mining men to bring to them specific changes upon which all mining men could agree, and if these changes seemed good they would be enacted into law.

It was with this idea in view that the council of the M. & M. Society said: "Let us see if we can find out what mining men think in regard to a number of questions, let us try to find out upon what points, if any, they are in accord. If there are any, perhaps we can get these enacted into law, if we cannot get the whole subject reviewed as we desire."

If the whole scheme had been the idea of "a dozen clever and interesting gentlemen," "whose opinions might be anticipated by a detached observer," the questions would not have been referred to 14 other organizations with membership of several thousand, nor would the answers have been published so fully, divergent as many of them are.

Mr. Editor, it is up to you to help us find out how many think that all the damage is done that can be done, to find out whether anything can be done to help the prospector and operator and not try to belittle a serious endeavor by ridicule.

A MEMBER.

New York, December 16.

Tinkering With the Mining Law

The Editor:

Sir—I have read several contributions during the past year or two in your journal on the subject of a proposed revision of the mining law. I am one of those that are opposed to very much 'tinkering' with the old laws with which we are all familar, but there is one phase of the existing law that has long been the source of discord, and which in my opinion could be amended to advantage. I refer to that part of the Federal law which requires an actual discovery prior to the location of a mining claim. Section 2320 of the Federal Revised Statutes declares that "no location of a mining claim shall be made until the discovery of a vein or lode within the limits of the claim located." This certainly is clear—no location can be legally made until the locator has an actual discovery of "mineral-bearing rock in place."

What is meant by "mineral-bearing rock in place"? It has been interpreted by the Department of the Interior and the courts to mean such a showing of mineral as would warrant a man of ordinary prudence in expending his time and labor upon the claim in the reasonable hope and expectation of developing a paying mine thereon, or, as expressed in a recent decision, "there must be actually physically exposed within the limits of the claim a vein or lode of mineral-bearing rock in place, possess-

ing in and of itself a present or prospective value for mining purposes."

Here we have both the language of the Federal Statute and its interpretation by the Department of the Interior and the courts. It is difficult to get away from the meaning of the statute, and it has been in the past the cause of much unnecessary trouble, to the extent of 'gun-plays' and even of killing.

It is not always possible to make a discovery without doing work—in some instances a great deal of work. For example, take that part of the Leadville district lying just south of the southern slope of Carbonate hill, where are some of the most valuable mines in the region—the Wolftone, Maid of Erin, Henrietta, Adams, Morning Star, Evening Star, Catalpa, and numerous others—not one of which has an outcrop of ore, nor does any ore occur in any of these claims within several hundred feet of the surface. Here, of course, was an instance wherein the expenditure of thousands of dollars was necessary before a discovery, such as the Federal law plainly requires, could be made.

True, there is but one Leadville, but there are other districts where the geological conditions are essentially similar, if not identical. There are scores of mining claims in the Black Hills of South Dakota, where there is no outcrop, and in some instances the area under which lies a great amount of profitable ore covers many hundreds of acres, and no outcrop is to be seen. The formation—limestone, sandstone, quartzite, and shale, is nearly flat, as at Leadville, and the ore-horizons sometimes lie several hundred feet below the surface. In other parts of the West where ore occurs in sedimentary formations, conditions similar to those above described are known to exist to an extent that makes them common. In California valuable gold-bearing veins and gold-bearing gravels in places are covered by hundreds of feet of andesitic lava, through which the miner must sink a shaft, before he can make a discovery. Since the conditions above described are not uncommon, would it not be well to recognize the fact and to amend the mining law so that a prospector may legally locate a claim where no ore outcrops, but where, in his judgment, he will find ore if the necessary work be done, not leaving the matter to the uncertainty of a decision by the courts, always a process involving much time and an expense beyond the means of the prospector?

A great deal has been said about the pernicious effect of the extra-lateral right. True, it is responsible for perhaps 90% of all mining litigation in the United States, but we now have a wagon-load or so of 'judicial legislation' on this subject, so that we know about 'where we are at' and it seems needless to change it at this late day, for it would result in a confusion far worse than that which naturally flows from the operation of this law as it stands. It may be that a few more new mining districts will be discovered in the Western States, but, unfortunately they are not likely to be many. It is more probable that future discoveries will be made in old districts and probably in such parts of these districts as have not yet attracted much attention by the richness of their ores, or because of the obscurity of mineralization or the absence of outcrop. Rochester, in Nevada, is a good example of the possibilities of the future in this direction, should the law of the extra-lateral right be repealed. Here was an old district, long idle, from which nearly every one had departed. The unexpected discovery of shipping ore in an old claim attracted immediate attention to the locality. A stampede ensued, and hundreds of new locations were made, blanketing the region for miles in every direction from Nenzel hill. In such a district, the effect of a law confining mining rights to vertical planes, as determined by the boundaries of the claims where there were old legally subsisting claims entitled to operate under the present law and many recent ones to work under such a new law as has been proposed, would simply result in chaos.

Let us not attempt to change the law so far as it relates to extra-lateral right, but see if something cannot be done to remove the difficulties of *bona-fide* location where no outcrop appears.

J. T. WILKINS.

Tonopah, Nevada, December 21.

Grinding-Mills at the Inspiration

The Editor:

Sir—I have read with interest your article on flotation, in the issue of October 28, with comment by Mr. Cole, and Mr. Cole's article of December 9 on the subject of grinding-mills at the Inspiration, and I naturally ask if Mr. Cole's articles are given without prejudice?

He states that the merits of the Hardinge and Marcy mills will be brought out in a test that is to be carried on by the Inspiration and Miami companies; that at Miami they are installing real Hardinge ball-mills arranged in a different manner than the Marcy arrangement at Inspiration, and yet he states that these results will be "conclusive." Does Mr. Cole think that the mining and milling fraternity will accept results as "conclusive" from him or anyone else in which the mills are operated in two separate plants, and while the ores are similar, yet their copper contents are entirely different, where orebodies vary from day to day as to their hardness, where the Hardinge mills are crushing the ore in two stages while the Marcy is doing it in one? Does Mr. Cole think that this "information will add materially to our knowledge of crushing"?

The pebble-mill has not yet been abandoned as far as I know, and it would be interesting if the Inspiration company or Mr. Cole would publish the long series of experiments and results that were carried on by the Inspiration company between Hardinge mills and a tube-mill. As Mr. Cole explains in the Transactions of the Institute, there were four different sizes of conical mills in the original test-plant and there was one tube-mill. We are sure that the manufacturers of this tube-mill,

the Chalmers & Williams Co., would be glad to have these results published.

My understanding is that the two conical mills that are now being placed at Inspiration were put in under a representation by the Hardinge company to do an equal amount of work as the present Marcy mills with very much less horse-power, namely, 300 hp. as compared with 450 hp., which is required for two Marcy mills. One thing the mining public is particularly interested in, is the amount in dollars and cents the Inspiration lost or gained by installing Marcy mills, and we hope Mr. Cole will give us this information.

Mr. Cole states Mr. Blickensderfer's article is unfair, on the comparative tests of the Marathon, Chilean, and Hardinge mills, because balls were not used in the Hardinge mills. This gentleman would not be unfair in making any comparison he chooses as long as he states the facts. I cannot see that it is unfair, particularly to one who is familiar with conditions. At the time the Marathon mill was installed by the Detroit Copper Co. in the summer of 1914, the standard equipment for crushing this character of ore in the Hardinge mill was flint pebbles, and that is what Mr. Cole was using also at this time at the Arizona Copper Co.'s plant. There was no available supply of cheap small iron balls that had been fully demonstrated a success that could be used in the Hardinge mill.

After all, the crushing problem is a matter of dollars and cents. Right here it is an interesting thing to know and to note that the success of re-grinding fine ores either in cone-mills or in cylindrical mills from a dollars and cents standpoint is due principally, not to Mr. Hardinge nor to Mr. Cole nor to the Miami Copper Co., but to the development of a cheap iron ball, called 'manganoid,' which is manufactured in a malleable iron foundry and extensively used by many, including the Miami and Anaconda companies. But could Mr. Blickensderfer have used iron balls without criticism from Mr. Cole, as they were not real Hardinge ball-mills? I am sure the mining public would like to know the exact difference between the real Hardinge ball-mills that are now being installed at Inspiration and the Hardinge mill equipped with 11 tons of steel balls that was used in competition with the Marcy mill during December 1914 at the Inspiration test-plant.

As to the work that is being done on crushing problems in the South-west, as mentioned by Mr. Cole, there are many other places where real experimental work has been conducted, but unfortunately results have not been published, as in the case of Inspiration. This refers particularly to the comparison at the Butte & Superior between a medium short tube-mill, a Hardinge mill, and a Chilean mill; to experiments conducted at the Alaska Treadwell between stamps and the conical mill; to experiments conducted at the Alaska Juneau, Alaska Gastineau, Britannia, and Braden mines. None of these results has been published, but many mill-men are familiar with the results and we all know the outcome of these experiments and the type of mill the respective companies adopted.

My conclusion is that the Blickensderfer article is a valuable contribution on the art of ore-grinding, as most practical men know the relative difference between ball and pebble mills in mesh-tons per horse-power; that the man who suggested the simplified crushing-system at Inspiration, or the men, or the company of men, contributed a most valuable idea to the mining public—an idea that has been copied extensively and successfully throughout the country—an idea that is highly valuable and most welcome to the small operator as well as the big producer.

The crushing of the ore is the one big expense in milling. What is required is exact facts, from which we can draw our own conclusions—conclusive or otherwise.

C. T. Van Winkle.

Salt Lake City, December 20.

The Prevention of Misfires

The Editor:

Sir—I have read with great interest the article in your issue of December 16, by Mr. E. F. Brooks, on this subject, which is one of great importance to California operators, for during last year 10 men were killed through misfires. This is approximately 25% of the total men killed from all causes, a record that compares very unfavorably with that of the average metal-mining State.

Mr. Brooks offers some excellent advice and touches on the following causes of misfires: poor judgment in placing drill-holes; the use of inferior caps and fuse; improper sequence in the 'spitting' of holes; 'spitting' too many holes by one man; the use of grease for waterproofing; and improper crimping of the cap.

There is omitted a cause of misfires that I believe to be of the utmost importance, namely, improper methods of making the primer. Any method of making the primer in which the fuse must be bent more than 35 or 40 degrees is likely to cause a misfire. Especially is this the case if the fuse is cold when the primer is made. The lacing method, and the method in which the capped fuse is placed in the end of the cartridge and the fuse bent backward (through 180 degrees) are most undesirable.

The U. S. Bureau of Mines, after extended experiments, made under varied conditions, found that there were two methods of making the primer that resulted in a minimum of misfires. These two methods, which are also recommended by manufacturers of dynamite, are as follows:

(a) Loosen the paper at the end of the cartridge, make a hole with a wooden punch, and insert the capped fuse. Then tie the paper about the fuse with a piece of string. In this method the fuse leads straight away from the cartridge, and thus is not bent.

(b) Make a diagonal hole in the side of the cartridge by means of a wooden punch. Place the capped fuse in the hole and tie the fuse to the cartridge near the top of the latter. The hole should be punched so that the fuse

will not be bent any more than is absolutely necessary.

It is usually claimed that it is impossible to compel miners to make primers properly. This object is being accomplished at many mines by the simple expedient of discharging the miner who makes the primer by any method other than the one he has been instructed to use.

If miners will follow the good advice given in Mr. Brooks's article, and will also make their primers properly, the number of deaths resulting from misfires must certainly be lessened.

EDWARD HIGGINS.

San Francisco, December 16.

The Editor:

Sir—In an article in your issue of December 16, 1916, E. F. Brooks argues against the use of tamping, stating that "even the air itself will offer sufficient resistance to the exploding dynamite to constitute good tamping." If such were the fact, bulldozing would be a most efficient operation.

The increase of the effect of good tamping is well known. From Technical Paper No. 17 of the U. S. Bureau of Mines publications, I extract the following: "The use of the most efficient stemming materials may increase the useful energy of the shot 93%, the use of the least efficient stemming materials may increase that energy 60%. Accordingly it is clear that the use of stemming is necessary when the maximum useful effect from an explosive is desired."

In the argument against tamping Mr. Brooks states that "the side-spitting of the fire in the fuse will sometimes set fire to the powder which, while it does not explode, will generate sufficient gas to force the tamping out of the hole, drawing the fuse with it." This statement indicates that the primer is placed at the bottom of the hole. In good practice today the primer is placed at the top of the charge. If it is so placed and the fuse is not laced through the powder, the fuse will not ignite the powder.

A cause of misfires often overlooked is the moisture in the fuse.

Berkeley, December 28. W. S. WEEKS.

Regarding Foreign Capital

The Editor:

Sir—Just a word of protest against Mr. Nipper's remarks on this subject in your issue of December 2.

Mr. Nipper puts me in the false position of being opposed to foreign capital entering the mining field in China. In my letter on this subject, to which he refers, I laid particular emphasis on the desirability of inducing foreign capital to come to China, and I merely suggested in a tentative way that some form of limitation might be desirable, at least from the Chinese point of view. Let me spell it out for the benefit of the most casual reader: I am in favor of foreign capital to develop mining in China and of giving it the fair deal. I beg to differ with Mr. Nipper when he says that China has no money to develop her mines. There is plenty of money in China, as anyone knows who is familiar with business conditions in the Orient. It needs only the stimulation afforded by a few successful mines and the encouragement of a good mining bureau to enlist this capital in mining. As for Mr. Nipper's concluding remarks, pointing out that there is loss as well as gain in mining, there is nothing very novel in that: we have learned that to our sorrow, even in China.

Los Angeles, December 9. M. B. YUNG.

Co-operative Trade Agreements

The Editor:

Sir—I enclose herewith Referendum No. 17 of the Chamber of Commerce of the United States, to be voted on on or before January 12, 1917.

You will observe that the subject of this referendum directly relates to the mining industry in that "the Committee recommends that there should be remedial legislation to permit co-operative agreements under Federal supervision in those industries which involve primary natural resources, on condition that the agreements in fact tend to conserve the resources, to lessen accidents, and to promote the public interest."

To conserve the mineral resources of the United States is a subject the importance of which can scarcely be over-estimated. It seems to me to be the most important economic subject we have before us, for if the United States is to grow as an industrial nation at the same rate that it has been growing in the past we must take care that the basic resources which govern industry are conserved to the fullest extent.

Before issuing this referendum our committee took the matter up with the Federal Trade Commission and with the American Federation of Labor. I cannot speak officially for the Federal Trade Commission, but I assure you that its members look favorably upon the general plan, provided the interest of the people is safeguarded in its execution. The American Federation of Labor has officially, through its highest officers, commended the proposition.

May we not have your editorial co-operation and support?

New York, December 21. W. L. SAUNDERS.

The Great Calamity

The Editor:

Sir—I have cancelled my table reservation for New Year's Eve dinner at a great hotel because I have read your masterly arraignment of cold-blooded neutrality as published in your issue of December 23 under caption 'The Great Calamity.'

I thank you for preventing me from unwittingly making an ass of myself. These are not times for hilarity, but for stock-taking in the house of human relationships.

San Francisco, December 29. PERCY WILLIAMS.

Financial Review of 1916

By Osmund Phillips, Editor of 'The Annalist'

As we begin another year it seems necessary to emphasize the fact that prosperity in the United States is not dependent upon the prolongation of the War. If we are to get out of this year's economic effort the fullest possible results for the country as a whole, business-men and bankers throughout the land should be impressed with the fact that the course which business will take will depend upon them and upon the people much more than upon the continuation of the struggle in Europe.

An eminent banker has recently been saying to his friends that the United States had already gotten out of the War all the prosperity which it was safe for us to extract from that particular source. It is not safe, certainly it is not desirable, to go on indefinitely serving the purposes of war to the necessary neglect of much in the way of peaceful demands and peaceful opportunity.

It is true that war has helped to enrich the United States. Also it is true that war has helped to impoverish Europe, which is a fact despite the surface prosperity that has attended the waging of the War in all of the great industrial countries engaged in it. Prices are high, labor was never so fully employed so far as it is available, and never were profits so rapidly attained. But in Europe these are all subject to existing and future taxation that the cost of the War makes inevitable. Directly we escape most taxation of that sort, but indirectly we could not escape the consequences of devoting a large and possibly an increasingly large share of our natural resources to the development of a war trade one of whose chief effects has been to throw our export trade out of all natural relation to our import trade.

That has brought in the flood of gold which has done so much to facilitate the financing of the unheard of volume of business thrust upon the country, and it has also brought back to us, by the billions, American securities formerly owned abroad. They were the outward evidence of America's indebtedness to Europe for capital invested here in developing transportation, in promoting industry, and in enlarging our power to trade. There is no hardship, but actual benefit, in being able to cancel this indebtedness and to become ourselves the owners of that portion of our industrial establishment which was formerly owned abroad. Besides the gold that we have received and the securities that we have taken back, we have also lent to the rest of the world on what for us was a very large scale. That, too, was well worth doing. It helped greatly in stimulating our trade and in supporting it, but there is a limit to the amount which could be judiciously invested in that way taking all the facts of the case into consideration.

An indefinite prolongation of the War would further dislocate the ordinary operations of industry and would eventually lead to our selling abroad more than our foreign customers could afford to buy. The test of that would not rest solely in their ability to pay the interest and the principal of the debt which they might contract with us. We have to consider their future, for as customers in the future as they have been in the past it is highly important to us that they should remain not only solvent but capable of buying goods beyond their bare necessities. The danger in our importing too much gold does not lay solely in our getting more than we could usefully employ in our own banking system. The danger lies in part in the countries of Europe draining themselves of gold to an extent that will weaken them so much that their recovery after the cessation of the War will be slower and much more difficult.

Coming back to our own industrial situation, it is clear that it would be particularly undesirable to increase further and further the capacity of plants devoted exclusively to the production of war goods and incapable of efficient production of goods of other sort once the War demand came to an end. That is not true, of course, of steel mills whose output is as available for the comfortable purposes of peace as they are for the stern purposes of war. A blast-furnace or a rolling-mill is by no means in the same category with the powder-plant or the gun-factory.

It is thus true that business might suffer greatly from a protracted prolongation of the War just as surely as it has benefited greatly, in the immediate sense, from the demands which the War brought into existence. It follows that the ending of the War is not a thing to be feared in the material sense. We have but to look a little bit ahead and to think of the morrow as equally important in the life of a nation as is today, to realize that the real material as, certainly, the moral interests of the United States will best be served by as early an ending of the war in Europe as is consistent with the attainment of a lasting peace.

I have dwelt at some length on this phase of the matter, for it seems important to combat the thought that prosperity in the United States is synonymous with the destruction of life and property in Europe. The loss of prosperity here would be surely a small price to pay for the return of world peace, but the fact of the matter is that that need not be part of the price. Many readjustments will be called for, but with intelligent planning those readjustments can be foreseen and met without undue disturbance. That is truer as matters stand now, or as matters will stand three or six months hence, than it would be were the War to last a year or two years more. The problems of readjustment will increase

in proportion to the inroads which the War will make upon the highest form of any country's capital—labor—and upon the natural resources of the world.

Looking back, what we find in the financial and business record of the past year is activity in a degree which would have been thought impossible before it was attained. Our foreign trade has reached a total falling in the aggregate only a little short of $8,000,000,000, while a total in the neighborhood of $5,000,000,000 the year before seemed an almost impossible accomplishment. Side by side with our foreign trade has grown our domestic trade, which, aside from all business directly due to the War—not to be regarded as exceeding the total amount of our exports—reached a volume never before nearly approached. If we did $8,000,000,000 of foreign trade, as foreign trade is usually spoken of, exports and imports together, we have probably done five or six times that much trade at home.

From both of these—trade at home and trade abroad—we have derived enormous profits. Evidence of that is seen in the increased dividends which American corporations declared and in the more secure financial position which so many of our business concerns have attained. The profits have been so large that few have felt like disbursing more than a fraction of them. It is one of the reassuring phases of the present time that the managements of most of our corporations have not proceeded on the theory that profits such as we have had this past year are to be expected indefinitely. The fact is that such profits are not needed to maintain a steady flow of prosperity. Excessive profits are of their very nature out of the ordinary, and imply conditions which cannot last. This has been recognized by nearly all business men even though individuals may have been more extravagant than has been wise. That, however, is inevitable, for no one puts up with bare necessities when something of luxury is within reach. Nor is what I am now saying a contradiction of the assertion that prosperity will outlast the War. I have in mind a normal prosperity probably on a lower scale of prices, but none the less effective in providing the wants of the people and in enabling them to enjoy the good things of life. Prosperity of that sort is better assured of so much of permanency as can attach to the fluctuating fortunes of human endeavor.

Things have already come about that will tend to lessen the extent of Europe's war purchases in the United States, even should the fighting, as still seems probable, continue for months to come. The Allied countries have been striving strenuously to render themselves so far as possible independent of other countries in providing munitions of war, and it has been pointed out semi-officially, as well as privately, that it was not to be expected that the Allies would place many more munition orders in this country. That is one thing which is working in the direction of cutting down our exports of purely war material. There are other forces working in the same direction.

If the countries of Europe could borrow here without limit they would no doubt buy many things which they will not buy if they find it difficult to provide the necessary money, and it is no longer as easy to get money as it was. Europe's holdings of our securities, particularly England's holdings of those securities, are still far from being exhausted, but the end of those resources is in sight. Of gold Europe still has a vast amount, but in international exchange gold is worth but its bullion value, and after all that does not go very far. If the gold which we received from abroad is not to be made the basis of credit to be granted to foreign customers as freely as we would grant it to our own customers, it follows necessarily that our foreign customers will have to buy less than they might like.

Real difficulty has been placed in the way of foreign financing in this country by the statement recently issued by the Federal Reserve Board, and, while further foreign loans are to be expected, it is most likely that they will be fewer in number and smaller in the aggregate than they would have been had no such check been put upon international banking operations. The matters which led up to the Federal Reserve Board's warning against the proposed issue of British and French Treasury bills was not handled as it should have been. The Board was placed in a position in which it felt compelled to make a public statement of the sort which it did make, and though that was in some respects unfortunately worded it seems likely that the final effect will be a good one. We should not extend foreign credits except to such borrowers and under such conditions as can stand the closest scrutiny. Presumably the countries in the best credit will find a means of providing for their essential credit requirements in this market and any credits beyond the least which are needed for the safeguarding of our own trade would carry us into speculative fields which it is not desirable that we should enter.

England and her allies are in a position to give us the best of security for hundreds of millions more in loans and are able besides to provide us with hundreds of millions of gold beyond what they have already sent. Between the two they are not likely to want means of paying for the goods which they most need. At the same time a restriction has been placed upon unlimited exports and the result of that should be good rather than bad.

The business and financial position of the United States is more intimately related with international affairs now than it has ever been in the past. That from one point of view increases the intricacies of trade and finance, but it is predicated on facts which have given us possession of strength greater than this country ever had before. The re-purchase of our own securities from abroad and the loans which we have made to others have converted the United States from a debtor into a creditor nation. From now on we shall draw interest from abroad instead of annually paying a large sum on the stocks and bonds of American corporations owned in other countries. But that is only one direction in

which the position of the United States has been and is being strengthened. The great impetus given to American shipbuilding by the scarcity caused by the War will in due course put this nation in a more independent position in respect to the trade-routes between America and foreign ports than it has occupied in many decades. The importance of this will be all the greater in view of the efforts which the exporting countries of Europe are likely to make to regain the trade that they have lost during the War. We shall after a while no longer be beholden to England or to Germany or to some other country for the ships which carry American goods to foreign ports or which bring to our own ports the raw materials produced elsewhere and needed here.

Moreover our industries have been relieved in part at least of their dependence upon foreign sources of supplies. That is the movement which should be carried much further and should be continued not only for the space of the War but beyond that time until we are making the most effective use possible of the materials which we have at hand. We have been a wasteful nation, but it is high time that we should accept the fact that our resources are not inexhaustible, nearly as they would come to being that if we used them as we should.

Much has been done to make the country great industrially and commercially, but a great deal remains that could be done which would greatly strengthen the country by increasing its productive capacity by rendering itself more efficient than it has yet become. If employers of labor foresee that the demand for their product is likely to be reduced by the coming of peace they should see how they can employ that labor in some other direction, or if that be impossible they should work with others to provide the employment which would be needed for those idle hands. This would be some of the most useful work which the manufacturers and merchants of this country could possibly do. There will be plenty of opportunity to employ profitably all the labor which may be released as a result of the ending of the War, but immediate work for that labor cannot be found unless plans are thought out in advance.

Fortunately, there is no doubt of the country's ability to provide the banking facilities needed for any effort which is to be made either at home or in foreign trade. Thanks to the creation of the Federal Reserve Banking system and thanks, too, to the support which bank reserves have received from the great inflow of gold, it will be possible to do things easily which would have been all but impossible under the older and less elastic scheme of banking. But only a beginning has yet been made in the direction of banking development along the lines provided in the Federal Reserve Act. Bankers should look forward to the time when all the banking institutions of the country will be united in a single system, each unit lending to the other the aid of its cooperation. Already a great deal more confidence is felt in the soundness of our banking position than was felt before the enactment of the Federal Reserve Act. Still more confidence would be felt were the facilities of that system availed of by all eligible institutions instead of being confined as it practically is now to the National banks. The Federal Reserve system has done two things: among others, it has made funds for commercial purposes cheaper than they were and also it has made the supply of these funds much more responsive to the trade needs of the country. The latter is the more important of the two. It is now unlikely that a check will be put upon worth-while trade merely from fear that the money with which to do it will be lacking. It makes relatively little difference whether a merchant has to pay 4 or 5% for his money; it makes a vast deal of difference if he can get money freely or cannot get money at all.

During the past year we have witnessed one or two flurries in the money market, but practically they have been confined to the Wall Street money market and even more narrowly to the Stock Exchange money market. A 15% rate there is of much less consequence to the country than would be a comparable rate for commercial paper. That is because speculation in securities is of no importance whatever in contrast with the conduct of trade. If speculators have to pay dear for the money which they use, few but themselves suffer. The same may be said of the losses which speculators undergo when, as happened this very month, the market structure which they have reared is suddenly subjected to greater pressure than it can bear. Speculating in stocks on margin may do speculators a lot of good if they are fortunate enough to take their profits in time, but the country at large gets very little good out of it. That is one reason why no great concern need be felt over the fact that stocks have fallen a good deal below the prices which obtained during the year. The properties which they represent were as valuable on December 21 when prices on the Stock Exchange were declining violently as they had been worth a month or two before when prices were rising rapidly. Without regard to the course which the stock market has followed the fact is that real values have increased during the year that has just ended. Corporations have earned much more in many instances than they ever earned before and the position of the holders of their securities is better therefor. It is certainly not to the investor's advantage to have stocks carried to high prices, possibly to prices beyond their actual worth, and it is not he who really suffers when prices built up on speculation yield to the inevitable.

Industry and trade looking backward find an extraordinary record of achievement during the past year, and looking forward they see many opportunities which will insure the continuance of at least as much prosperity as the country needs if the opportunities are intelligently availed of. Business men should lend their aid to every efficient effort which may be made to make sure that whenever the War may end and whatever changes the year may bring, new work may be found for every hand that may become idle. In a country of resources as great as ours still only partly developed, there can be no good reason why any willing hand should be idle, and without idleness there can be no real lack of prosperity.

Tungsten Manufacture in England

*Although the British Empire contains some of the most important sources of tungsten ore, before the War it depended mainly on Germany for the metallic tungsten needed for the manufacture of high-speed steel, and when hostilities began only enough for three months was on hand. Under these circumstances vigorous measures were required to remedy the deficiency, and in a few weeks a company, High Speed Steel Alloys (Limited), was formed for the purpose. Arthur Balfour, of the Dannemora Steel Works at Sheffield, who took a leading part in its establishment, was chosen chairman, and A. J. Hobson, of Messrs. William Jessop & Sons, vice-chairman, while the capital was subscribed by some 30 steel-making firms, mostly belonging to Sheffield, and collectively producing from 70 to 80% of the high-speed steel made in this country before the War. The company, of which Julius L. F. Vogel is manager, started building operations on a site of about six acres at Widnes in Lancashire at the end of 1914, and by the following July the factory was producing tungsten powder. Work has since been carried on continuously day and night, though the output, which has reached three tons daily, has occasionally been reduced through lack of the necessary supplies of ore. There is no secret in the process of manufacture. In the first department of the factory the wolfram ore is crushed, screened, and mixed with soda ash. Here a magnetic separator, for separating the wolfram from the tin ore which it contains, is temporarily installed, but an entirely new building for the grinding, roasting, and magnetic separation of mixed ores is now being erected. In the second department the mixture of ore and soda is roasted in reverberatory-furnaces, and then the product is taken to the third department, where it is broken up. The next process consists in boiling it with water, when the tungsten is obtained in the form of a solution of tungstate of soda, which is freed from solid impurities by filtration, and then, in the fifth department, treated with hydrochloric acid. The result is to deposit tungstic acid, which is obtained as a thick yellow paste. This, after being dried and powdered, is packed into crucibles with powdered anthracite, and the next step is to reduce the oxide to metal by heating the crucibles. At present coke furnaces are employed for this purpose, but a continuous furnace 130 ft. long, and fired with producer gas made by two Wilson producers using bituminous coal is being erected and is expected, by replacing the coke furnaces, to reduce costs considerably. Finally, the metal from the crucibles is washed and dried and packed in tin-lined wooden cases for delivery to the steel makers. The tungsten produced has had an average purity of 98½%, or 1% more than that previously obtained from Germany, and a substantial proportion has averaged over 99%. This purity is of marked advantage to makers of high-speed steel, since it reduces the wear and tear on crucibles, preventing the loss of steel through damaged crucibles, and promotes the yield of sound ingots, which can be hammered and rolled into finished bars of uniform high grade with a minimum of waste and defective material. But to maintain it continual care is required, and daily assays are carried out of all raw materials and intermediate and finished products in a laboratory in which there is also a staff of chemists engaged on research work for improving the methods.

*Abstract from *The Times* engineering supplement.

The Tungsten Situation

*While the present price of tungsten at $20 per unit permits of the profitable mining of the mineral particularly in the medium and high-grade properties, current quotations hardly seem in accord with the existing situation as regards supply and demand. Users of tungsten are not over-stocked, but on the contrary, are likely to experience considerable difficulty in filling their requirements. It is an open secret that the large steel manufacturers have formed a combine to keep down the price of the metal; but as their needs grow more urgent, and when they are brought into competition with foreign bidders, it would seem as if quotations on tungsten must record a material advance, regardless of bearish manipulations. Knowing that the demand equals and probably exceeds the present output, tungsten producers should be able to form some sort of protective organization of their own, and refuse to part with their production except at a fixed and reasonable price. The foreign situation for tungsten is extremely bullish. In Great Britain alone plants now in operation for the production of tungsten concentrate cannot obtain a sufficient supply of ore to keep running at anywhere near capacity. Such an authority as Admiral Slade is quoted as expressing the belief that there are now in Great Britain sufficient plants to deal with more than twice the amount of ore that can be procured or is ever likely to be procurable. There also are important works in France that will consume a good deal of the metal. In the United States the Primos Chemical Co. has within the past year considerably enlarged its capacity, and the Chemical Products Co. has recently completed a new large reduction plant near Washington, D. C., designed particularly for the treatment of lower-grade concentrate. The steel interests generally, carrying heavier bookings than ever before, are absorbing their due quota of the mineral. There is another factor in the situation not to be overlooked or under-rated, and this is the projected great enlargement of the United States navy, whose great steel battleships, as well as the minor vessels, will call for a big supply of tungsten. At the annual meeting of the Colorado Metal Mining Association, to be held at Denver in January, the tungsten situation will be one of the most conspicuous subjects brought up for attention; and it is to be hoped some line of procedure will be evolved adequately to protect the producers and stabilize prices at more suitable levels.

*Abstract from *Daily Mining Record*.

Flotation in 1916

By An Occasional Correspondent

No one could have predicted three years ago that the flotation process would have expanded so rapidly in this short period that the quantity of ore to be treated daily —in the world—would amount to 150,000 tons. It is a reasonable expectation that this tonnage will be doubled in another three years. The mills of the gods are beginning to grind not only "exceeding small" but exceedingly fast.

Exchange of technical information has contributed largely to this result. Metallurgists have learned that it is difficult to keep secrets—so why have secrets? If you appear anxious to tell your professional brother something that will help him, the psychological effect is to make him want to tell you all that he can to help you in return. The result is improved practice for both. Time was when the operations in metallurgical plants were carefully guarded, and supposedly valuable processes were directed by supposedly wise men. In almost every case these secret plants were found to be harboring secrets, not of technical success, but of failure. Many of these plants were losing too much in tailing, in slag, or in flue-dust, or in some other less accountable way. Some of them were superintended by men who were aware of their own shortcomings and who knew they were not doing good work. The companies for whom they worked had little ore to treat, or a very low-grade ore, and did not wish the investing public to be told the truth. Manipulation of stock-markets is more easily accomplished if the metallurgical operations of a company are conducted in secret. Sometimes there are sinister reasons for secrecy, as the mining fraternity knows full well. Suspicion is aroused when a plant is operated behind closed doors, and while the layman may be impressed by the high fences and the numerous watchmen, the very fact of secrecy generally suggests incompetence or dishonesty to those who are versed in technology. For this reason the attempts a few years ago to stifle the publication of technical information concerning the flotation process met with decided resistance from members of the profession. Whether rightly or wrongly, the impression became general that the Minerals Separation people were enforcing a clause in their contracts with those that dealt with them, requiring such to withhold all information on experimentation and demanding that they destroy the experimental machines used in testing the ores. It was given out that the M. S. company did not want information on the process to come from any one but the accredited engineers of the company. Also they expected such high royalty for the use of their process that it was virtually a hold-up. This was the impression that obtained and whether it was correct or not is not the immediate question. In reaction against this impression the independent metallurgist told all he could learn about the process. The sudden flood of literature that appeared in the technical press surpassed anything that had ever been done in making clear the exact workings of a metallurgical process and no one who can read need lack information.

The process had been laughed at for years by American metallurgists, then mildly tolerated, and then allowed a restricted field of application, but it was not taken up with enthusiasm for the reason that nearly every engineer who tested it in a laboratory ran into difficulties that he could not understand, and he gave it up. It was the general impression that the process was too delicate and too restricted in its application. It is to the great credit of the Minerals Separation people that they early saw the tremendous importance of this process in case it could be made to solve the slime problem in milling. Since they had expended a fortune in bringing the process to a commercially practicable stage, it was natural that they should expect a high return for the use of it, and further, that they should desire that all the technical information given to those using the process should come from their office. It was not surprising that they should endeavor to keep the application of the process in such a state that they would possess more technical information than anyone else, so that infringers could not hope to have the same success as the licensees.

This is all easy to understand and many sympathize with them in their wish to develop their process along such lines, for the amount of money that they had expended in reaching the point they had achieved was considerable. Unfortunately much of this money had been spent in litigation in the British and Australian courts and there was still a question as to just what rights they did own. So, when a rather high royalty was asked for the use of their process, there were those in America who felt that the question of ownership of patent rights was too much in doubt for them to pay the tax. When the total cost of milling in such a region as south-eastern Missouri is about 25c. per ton, and the total cost in Utah is not much more, operators naturally balked at the payment of a 25c. royalty on every ton of ore. This reluctance on their part was further aggravated by the understanding that the Minerals Separation Co. insisted on applying the royalty to every ton of ore entering a mill, whether or not the ore was all treated by flotation. This was due to the idea of the M. S. people that their process could be applied to the total mill-feed without the use of many auxiliary machines, thereby simplifying the flow-sheet as well as bringing a greater return into the coffers of the company. In consequence, the profession

began to feel that the Minerals Separation Co. was too greedy, and it now seems that the company made a great mistake by allowing this impression to get about. The royalty now asked is not 25c. per ton—in most cases it is considerably less.

None of us wants to see any set of men lose money after developing to a stage of commercial success so useful a process as the one in question. But if the impression prevails that a company is trying to claim everything in sight in the flotation field; that it is not looking for sympathy; that it is going to insist on its legal rights, as given to it by the United States patent laws; that it is going to charge all the royalty that the traffic will bear, and that it is going to give no more technical information than is necessary for the profitable operations of its own clients, then that company makes a great mistake in policy. That impression still prevails, and has resulted in the flood of literature on the subject. Engineers have tried to make sure that everyone should so thoroughly understand the process that none should be at the mercy of anybody.

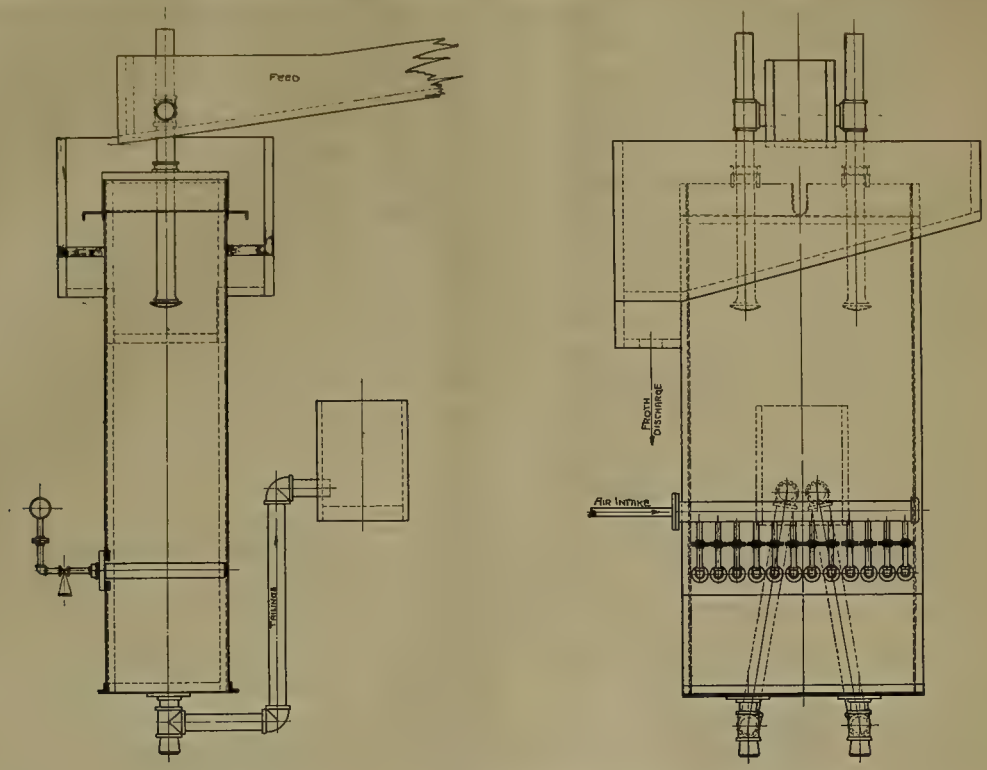
The rapid application of flotation came with the realization that it was a process adapted to the treatment of slime, and also that it had been developed to a stage where it was not such a delicate operation as had at first been supposed. The chances of losing money by the installation of a process that might fail were lessened. The world was in need of it, because the magnitude of milling operations, with attendant losses, had become enormous. Then the War created an unprecedented market for metals and sent prices to such figures that the utilization of any process that promised success was hastened. Costly mistakes could be corrected and the losses promptly stopped. A vast amount of investigation has been done in adapting flotation to the treatment of various ores. There were hundreds who set up laboratory machines and used them in testing their own ores. Every old mine-dump, or mill-dump, or accumulation of tailing in the bend of some stream, or deposit of low-grade or of complex ore, is being tested to see whether flotation will make it a source of money. The application of the various flotation processes is being extended to ever wider fields. Oxidized ores of lead and of copper, ores of gold and of silver, scheelite, the Sudbury copper-nickel ores, and even anthracite culm, is being tested by flotation, and a first failure in test work is no longer considered as final evidence of the inadaptability of the process. Confidence is felt that ultimately some method of treating all of these materials, and others, will be devised. The time soon will come when even the 'pay ore' that is now going to the furnace will be investigated with a view to ascertaining its amenability to flotation and by fine-grinding converted into a more concentrated material of a self-fluxing composition. Wherever an expensive operation is being carried on, or a high freight-rate is being paid, an effort will be made to obtain a higher concentration of the material in order to reduce the cost. In other words, the flotation process is proving to be not only an instrument for the conservation of our national resources by making a higher recovery possible, but it has cheapened processes and developed new resources by treating ores that were formerly too complex for concentration by other methods. The past year has seen much of this, and the coming years will witness many other innovations in metallurgical methods.

At first the treatment of flotation-concentrate by smelters seemed to be a serious problem, and it is still a difficulty. Some of the lead smelters have considered raising the roasting cost on this material. The copper smelters have found that they can handle flotation concentrate fairly well in the reverberatory furnace, but the zinc smelters have not been able to prevent the unusually large dust-losses during roasting. At the beginning of 1917 the opinion is forming that the fineness of division of the flotation-concentrate will be turned to advantage in new methods of metallurgy soon to be developed. At Clifton, Arizona, an investigation is now under way to find a method of leaching raw copper-sulphide flotation-concentrate without drying. The finely ground material is in ideal condition for a hydro-metallurgical process. The possibilities of using this new method effectively are only beginning to be appreciated. Flotation was first used to stop losses, then applied to ores that formerly could not be treated, then to the cheapening of former processes, and soon it is going to overthrow the former standard metallurgical processes and develop methods of ore treatment that will in some instances result in the direct production of metal at the mine. This last is greatly to be desired in a country where great distances and high freight-rates permit the transportation of only the most highly concentrated products.

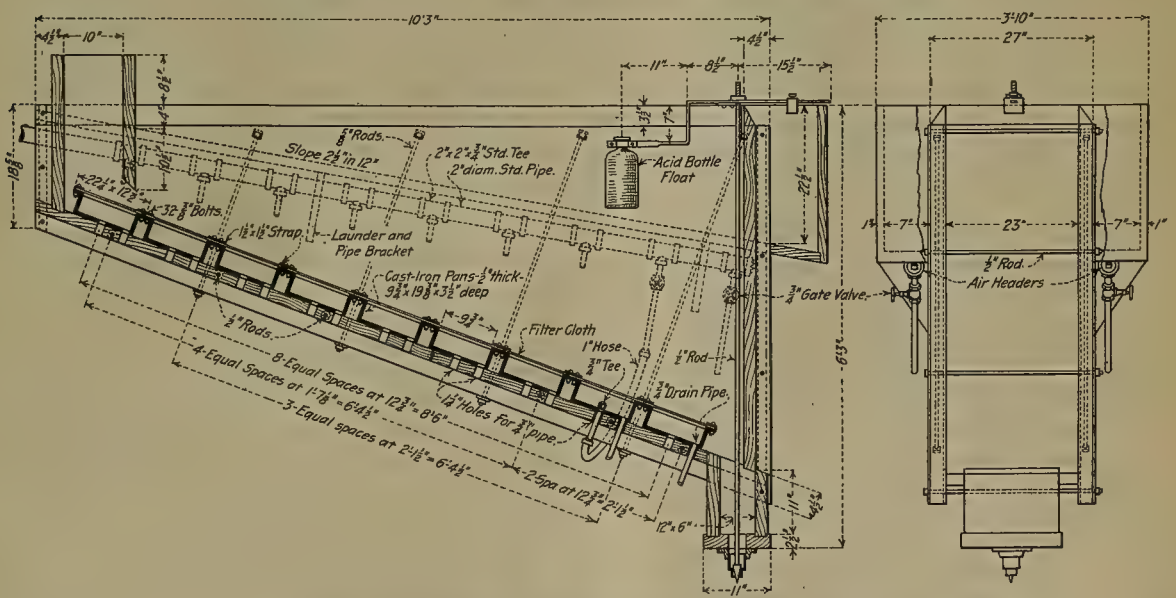
Great ingenuity is evident in the development of oil-feeders and there are now devices available that will feed oil for either the largest or the smallest mill at a uniform rate and without danger of clogging or otherwise going wrong. The mechanical handling of flotation-froth after it has been made has also received much attention. It has been found that tough froth is easily broken by a spray of water traveling at a high velocity. A solid stream of water is far less effective. After breaking, the thickening of the pulp for proper filtering is important, as a wet flotation-concentrate causes endless trouble both in shipping and smelting. The froth is never completely broken down and as a result it occasionally collects on the thickeners to depths of several feet and special arrangements have to be provided for prevention of loss in the overflow. The vacuum-type of filters, especially those that operate continuously, have received almost universal acceptance.

A better understanding of the process has resulted from the many theoretical papers published during the past year. The two principal theories are those depending on surface-tension phenomena and those which are more frankly 'colloidal.' Bancroft has stated that we have here a special case of oil-emulsions in which water is the dispersive phase and the oil is trying to be the continuous phase, although used in such small amounts as

to be almost lost in the ore-pulp. The whole subject is in need of revision by somebody who understands all the theories that have so far been advanced. The ordinary metallurgist is at sea in the midst of the many new terms other, but their work requires to be harmonized and edited by some one not interested in upholding any particular theory. Already a number of engineers who have read these papers with attention have been able to



SIMPLE TUBE-GRATE CELL AT THE ARIZONA COPPER CO.'S MILL, MORENCI, ARIZONA.



DETAILS OF FLOTATION-CELL AT THE CALAVERAS COPPER CO., CALIFORNIA.

used by the conflicting theorizers. Actually there is little room for conflict, as most of the parties to the arguments have a few truths that they are trying to make universal. Most of them are right in one way or an- solve perplexing difficulties in their practice and have made experimental observations which support the various theoretical points advanced. Flotation has been admitted to be a rather delicate process and difficulties

unexpected and puzzling often develop that are inexplicable.

With the further development of rational theories these difficulties will be better understood and finally overcome. At the present time many of the disturbing substances have been identified and the usual course now pursued is one of prevention—keeping out the substances or factors which cause the trouble. The next step will be to find a corrective measure that will successfully treat by flotation a lot of ore that has been spoiled by the entrance of some disturbing factor.

By the beginning of 1916 the development of the flotation process had been such that it was possible to estimate the probable tonnage to be treated by the end of the year. No embarrassment ensued like that due to the scarcity of suitable oils in 1915. Oils still cost money but the oil companies have been accelerating their production and presenting other products for flotation use in addition to those previously in demand.

At the present time the tonnage of ore being floated is approaching 50,000,000 tons per annum and it is certain that it will pass that mark during the coming year. Of course, not all of this is in the United States. The tonnage in the United States is difficult to estimate on account of the litigation, but it is thought that about 30,000,000 tons annually is a rather low estimate. Anaconda and Inspiration alone are milling together about 11,000,000 tons of ore that goes through flotation-machines.

Referring to the oils again, it is little matter of wonder that there should be some difficulty in obtaining pine-oil and other valuable products after the sudden expansion of flotation in the past three years. The War threw an additional burden on the turpentine and pine-oil producers, and the result was that prices soared. Coal-tar and coal-creosote became popular and during the past year there has been some difficulty in obtaining supplies of them at reasonable prices. For once it has been the buyer who has had to get down on his knees and beg. This situation is already being relieved by the further use of tars east of the Rocky Mountains. All of the coal-gas plants in the inter-mountain region can now market their tar and creosote, whereas three years ago it was a drug on their hands. With the finding of local uses for ammonia and gas it is believed that the use of by-product coking-plants in the West is nearly at hand. All of the coke made in the inter-mountain region is now beehive-oven coke and the by-products are wasted. Already there seems to be a chance to combine ammonia with the phosphoric acid from some of the phosphate deposits to make a double fertilizer which will be in a form concentrated enough to stand shipment to the points of consumption. The metallurgical use of the gas from by-product coking-plants is not difficult. In other words, the probable effect of the sudden expansion of the flotation process will be to make possible the building of by-product coking-plants in the inter-mountain and Pacific Coast regions.

The year has seen great development in the use of other oils than the coal-distillation products. The destructive distillation products of pine, cedar, fir, hardwoods, and sage-brush have gained in favor. While the idea of sage-brush oil at first seemed laughable, it does not seem to be an impossibility. It would appear that a 4% yield of sage-tar is practicable and that it is the full equivalent—if not the superior—of pine-oil for many purposes. If it can be sold in the West for 50 cents per gallon, it will become a serious competitor of pine-oil at 40c. in the East. It is possible that the cost of production of sage-brush oil will be as low as 50c. per gal. in a crude plant and there is no knowing how much cheaper it might be made by proper organization and engineering.

The commonly accepted division of flotation-oils into 'frothers' and 'collectors' has met general acceptance and at the present time the coal-products are being used as 'collectors,' together with other non-frothing oils, such as crude petroleum or various petroleum-distillation products. For 'frothers' the pine-oils, soft and hardwood creosotes, and coal-creosote are now being largely used. Sage-brush oil is classed as a good 'frother.'

Much has been done during the past year in developing mechanical appliances for flotation. The reports on the work at Inspiration, at Morenci, at Anaconda, and other places, have shown widely different equipments. At Anaconda the standard type of Minerals Separation machine has been at work. It has shown that it consumes more power than a pneumatic machine if the oil is added to the tube-mills before final grinding of the ore. However, at Anaconda the oil used is an acid-sludge and must be added to the flotation-machines. This puts the burden of emulsification on the flotation-machine and would make a pneumatic equipment as expensive to operate as the Minerals Separation machines at Anaconda.

Much has been heard recenty of 'sub-aeration' machines, the air being added beneath the paddles of a 'mechanically agitated' flotation-machine. This is said to result in a saving of power and of flotation-oil, and occasionally it gives a better recovery of the mineral being concentrated. The Minerals Separation company and its engineers seem to own most of the sub-aeration patents and this machine seems to be an answer to the pneumatic machines that have been developed out of their hands.

Pneumatic machines of all shapes and sizes have appeared in practice during the past year. Many of them are close imitations of Callow's original device. The Inspiration machine is notable for its simplicity. It is the development of a launder with a porous bottom for admitting air. At the present time it is built as an iron box divided into compartments about three feet square, each connected at the bottom to the next one and with barely enough slope to cause the pulp fed to the first box to gravitate through the machine. An air-basket with a canvas top is placed on the bottom of each compartment and supplies the air for flotation. These 'baskets' are fed by a pipe leading down from a header above the series of compartments, and can be disconnected or removed individually without stopping the ma-

chine, if necessary—the one compartment running empty, with no froth. The main advantage of this machine over the original Callow cell is its tonnage for a given amount of floor-space—a consideration of prime importance in the immense Inspiration mill.

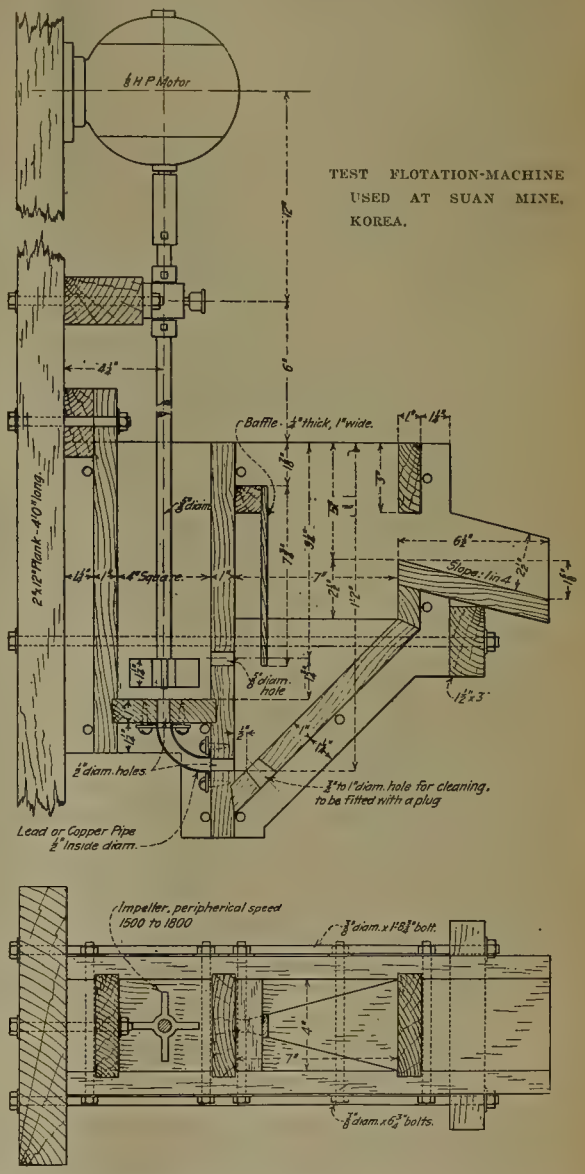
The idea of individual air-baskets for use in what is practically a Callow cell has also been applied in the Hyde and Calaveras modifications. In the Hyde machine each separate wind-box on the bottom is fed through a hose from a header along the top and likewise allows of the removal of an individual air-basket for repairs without stopping the operation. The Calaveras machine is not capable of this arrangement, as the air-feed pipes to the individual air-baskets enter through the bottom of the cell.

In one of the mills at Cobalt, Ontario, Mr. Callow has lengthened one of his machines from the standard 8-ft. cell to a 30-ft. cell. This in effect makes it a launder with a porous bottom for the introduction of air. With the much smaller slope involved in one of these cells the accumulation of sand would cause trouble, but this particular machine is intended for the treatment of a very finely-ground product that has very little sand in it.

One other pneumatic machine of interest is that used in one of the Belmont mills and designed by George Crerar. It consists of a series of launders about six feet long by one foot wide. The launders have porous bottoms and are placed side by side. The pulp enters the first one, passes through it to the end, then through a hole into the next one and back to the front, thence into the next one and to the back, and so on. This gives a considerable distance of travel in the frothing-launders before the tailing is discharged.

Still another interesting machine is the 'C-B,' named after its designers, Cole and Bergman. It is also pneumatic, but introduces air into the bottom of a cell through pipes that are perforated and wrapped with canvas, in order to break the air into small bubbles. The pipes are spaced across the cell at some distance above the bottom and the sand can sink down between the pipes and be removed from the bottom. This has given rise to its name as the 'frothing classifier.' The present form discharges the whole tailing from the bottom and everything has to pass down between the pipes. Mr. Cole believes that flotation should be used ahead of the tables in a plant treating both sand and slime. The idea is that the fine particles in the slime and some of the coarser mineral will be removed in the flotation-machine and that tabling of the coarse mineral left in the tailing from the flotation-machine should then be an easy matter, and could probably be accomplished without classification. This sounds reasonable, and it suggests the further advantage that when the flotation-machines happen to go wrong for a short period much of the minerals that they do not float would be caught on the tables below. Some engineers have objected that they have not been able to get as good results by following Mr. Cole's plan, claiming that the slimed gangue caused poor tabling work of the mineral sand. This is a point that needs further elucidation which it doubtless will receive.

A most interesting machine that has been developed to a commercial stage during the past year and is now being sold, is the K. & K., named after its inventors, Kraut and Kohlberg. This machine is agitated mechanically; it has a horizontal drum revolving inside a


½ H P Motor
Baffle ¼" thick, 1" wide.
2"diam.
2"x 2"Plank - 4'0" long
1¼" x 1" Square
⅜" diam. hole
½" diam. holes.
Lead or Copper Pipe 2" inside diam.
Slope: 1 in 4
1½" x 3"
Impeller, peripherical speed 1500 to 1800
⅜" diam. x 1½" bolt.
⅜" diam. x 6¾" bolts.

TEST FLOTATION-MACHINE USED AT SUAN MINE, KOREA.

cylindrical casing and dipping into the pulp to be agitated. The pulp is whirled between the drum and the casing and thrown through the air at the top into a spitzkasten, where the froth can be skimmed off. Riffles and holes in the drum cause the pulp to be aerated by air drawn out by the centrifugal force. The power consumed by this machine is said to be less than 2 kw-hr. per ton of solid as compared with about 3 kw-hr. per ton for pneumatic machines and nearly 4 kw-hr. for Minerals Separation machines.

The development of differential methods has progressed and there are now several plants in the Northwest treating mixtures of zinc and lead sulphides and making a good separation. Copper and iron sulphides are being separated at several plants in California and elsewhere, and one of the interesting problems remaining is the separation of zinc and iron sulphides. The Sudbury ores are being attacked in the hope of removing either the copper or the nickel sulphides, so that the metallurgical methods of separating the copper and nickel may be changed.

The flotation of oxidized ores has assumed importance. By filming the ore with a solution of a soluble sulphide it is possible to convert oxidized minerals superficially into sulphides that can be floated by the usual flotation methods. At the Magma plant at Superior, Arizona, hydrogen sulphide in small amount is being introduced into the suction of a centrifugal pump for sulphidizing and a good extraction of oxidized copper minerals is obtained. At the Prince Consolidated plant near Pioche, Nevada, a mill is treating oxidized lead-silver-gold mill-tailing with a solution of sodium sulphide followed by flotation. A high extraction of the lead and a lower extraction of the gold and silver are being obtained. The success of the Magma plant doubtless will lead to the use of the process on many other copper ores, and the developments at the Prince Consolidated will be anxiously awaited, as the successful treatment of this lead carbonate ore will probably mean the extension of the process to an ore that it has been difficult to treat successfully.

Flotation has also invaded the field of gold and silver metallurgy. Most of the ores that are difficult to cyanide can be floated, and in some cases the rich minerals can best be concentrated by flotation before being cyanided. The general consensus of opinion seems to be that flotation will prove to be a valuable accessory to cyanidation, rather than a serious competitor. It will permit the preparation of a final product ready for cyanidation that can be treated more carefully in order to lower the consumption of cyanide and other chemicals. This will apply largely to the ores that are difficult to cyanide and that usually demand a considerable amount of time, fine grinding, etc., for their extraction. Goldfield, Cobalt, and Cripple Creek seem to be the leaders in the use of this new method for treating precious-metal ores.

In California, the flotation of mercurial ores is being considered; in Minnesota, it is thought that even magnetite can be floated; in the Black Hills, scheelite may be made to attach itself to the little air-bubbles; in Kentucky, it is thought that possibly fluorite may prove docile; in Pennsylvania, anthracite coal in the culm is now being attacked. Who knows to what other ores this process may be adapted?

The further inroad of flotation and hydro-metallurgy on the smelters is to be expected in the years to come. The difficulties faced by the smelters in the handling of flotation concentrate are leading to proposals to leach such concentrate without dewatering it. At the Arizona Copper Co.'s plant at Morenci a concentrate of copper sulphide is soon to be leached. One of the prime requisites for rapid hydro-metallurgy is fine division of the material to be treated, whereas this condition creates difficulties in smelting. If the copper smelters wish to hold their own they must be prepared to handle flotation concentrate without penalizing their customers on account of the fineness of their products. Otherwise hydro-metallurgy will invade their field. In fact, the direct production of metal at the mine is the goal of all metallurgy. If crude ore enters at the head of a mill, is concentrated by flotation, and then the flotation concentrate is leached without filtering and drying, one of the worst sources of trouble and annoyance will have been removed and the product of the mill will probably be black copper, or even electrolytic copper. As far as lead and zinc ores are concerned, it will be harder to devise a hydro-metallurgical method that will treat the raw sulphides, but reagents like chlorine are known to be effective in attacking them and the idea is not impracticable. As far as gold and silver are concerned, the idea to cyanide the concentrate is not at all revolutionary and does not seem as radical as the proposal to leach copper or other concentrates.

Taken in its broad aspect, flotation has seen a rapid development in its application to slime generally and to the treatment of disseminated copper ores in particular, but now it is being more seriously considered in the light of a new means to be used in conjunction with other than the gravity type of concentration.

Massive rock that is to be used in concrete, or in building structures of various kind, should be carefully investigated as to its fitness for the work. A medium-coarse diorite that, apparently, was firm, upon being placed in a breakwater at Eureka, California, rapidly disintegrated after exposure to the salt water. A microscopic examination of this rock showed that the feldspar was much decayed and kaolinized, which evidently unfitted it for the use to which it had been put. Other similar-appearing rock in the breakwater remained firm under identical conditions. This latter rock, under the microscope, showed the feldspar to be still fresh, or at least little altered. It is probable that due to the tides, the rock of the breakwater was alternately wet and dry, and that the salt, entering the intersticial spaces of the partly decomposed rock, upon drying crystallized and thus gradually brought about the disintegration of the diorite. Here is a good example of the tremendous expansive force of crystallization, notwithstanding the fact that the crystals were of microscopic size.

An important discovery of copper ore at Little Bay, 200 miles north of St. Johns, Newfoundland, has recently been announced. It is said the deposit is 300 ft. wide containing disseminated-copper sulphide with veins of chalcopyrite 1 to 2 ft. wide running 25% and over in copper.

Metal Production in 1916

Advance statements of the U. S. Geological Survey, covering the past year include the following:

ALASKA

In 1916, Alaska mines made a mineral production valued at $50,900,000, figures based on estimates made by Alfred H. Brooks. The output of Alaska mines in 1915, which was greater than that of any previous year, was $32,850,000; the increase in 1916 was therefore over 54%. It was the product of the copper mines that so greatly swelled the mineral production of 1916. This amounted to 120,850,000 lb., valued at $32,400,000; in 1915 this was 86,500,000 lb., worth $15,100,000. There was also, however, an increase in gold output, which in 1916 was $17,050,000; in 1915, $16,700,000. Of the gold produced in 1916, $10,640,000 is to be credited to placer mines. The value of the lesser mineral products in 1916 was about as follows: silver, $950,000; tin, $120,000; lead, $110,000; antimony, $60,000; tungsten, $50,000; coal, $30,000; petroleum, marble, gypsum, etc., $130,000. During 32 years of mining, Alaska has produced $351,000,000 in gold, silver, copper, and other minerals. Of this amount, $278,000,000 represents the value of the gold, and $68,000,000 that of the copper.

It cannot be expected that Alaska will continue to produce so much mineral wealth each year, yet the large amount of preparation made in 1916 for lode and placer mining and the development of the coal-mining industry, now assured, give promise of a continuous healthy growth of the mining industry of the Territory. This is especially true of the Pacific Coast region and of that served by railroads built or under construction.

About 640 placer mines were operated in 1916, employing some 4600 men. All the older districts appear to have held up or increased their output compared with the previous year, except Fairbanks. The increased output is, however, to be credited chiefly to the new camps of Marshall and Tolovana. Thirty-six gold dredges were operated in Alaska in 1916, one more than in 1915—29 in Seward peninsula, three in the Iditarod, and one each in the Ruby, Fairbanks, Circle, and Yentna districts. Of these 36 dredges four were installed in 1916. It is estimated that these dredges produced between $2,000,000 and $2,200,000 worth of gold. If the final figures bear out this estimate, it indicates a lower recovery per dredge than in the previous year. In 1915 the 35 dredges mined $2,330,000 worth of gold.

About 25 gold-lode mines were operated in 1916, compared with 28 in 1915. The value of this gold output increased from $6,069,000 in 1915 to about $6,200,000 in 1916. South-eastern Alaska, especially the Juneau district, is still the only centre of large quartz-mining developments in the Territory. Next in importance is the Willow Creek lode district. There was also considerable gold-lode mining on Prince William sound, but a decided falling-off of this industry in the Fairbanks district. Lode-mine owners of Fairbanks are awaiting the cheapening of operating costs, especially of fuel, which will be brought about by the Government railroad.

The enormous copper output from Alaska mines in 1916 has already been referred to. During the year 18 copper mines were operated, compared with 13 in 1915—seven in the Ketchikan district, eight in the Prince William Sound district, and three in the Chitina district. The great output from the Kennecott property, in the Chitina district, overshadowed all other operations. Had the transportation companies and smelters been able to handle the ore, however, many of the smaller copper mines would have made a much greater output. It is estimated that about 550,000 tons of copper ore was hoisted in 1916.

About 232 tons of stream tin was produced in Alaska in 1916. Of this about 162 tons came from the York district, where two tin dredges were operated, and a third was working on placer ground carrying both tin and gold. Developments were also continued on the Lost River lode-tin mine. The rest of the concentrates were recovered incidentally to placer-gold mining in the Hot Springs district of the lower Tanana basin.

The mining of antimony ore (stibnite) began in Alaska in 1915, and continued in a small way through the first half of 1916. The fall in the price of antimony during mid-summer put an end to most of these operations. About 1460 tons of crude ore was mined and shipped during 1916. Much the larger part of this came from the Fairbanks district.

Though scheelite has long been known to occur in some of the Alaska placers, up to the last two years the demand for it has not been sufficient to encourage its recovery. The recent high price of tungsten has induced Alaskan miners to turn their attention to scheelite deposits. In the fall of 1915 a scheelite-bearing vein was discovered in the Fairbanks district, and its development begun. Later two other scheelite-bearing veins were found in the same district. During the winter some of these scheelite ores were treated in a local mill, and the concentrate was shipped out by parcel post. Scheelite mining was continued during the summer, and the crude ore was shipped out by steamer. Considerable scheelite was also recovered from some of the gold placers at Nome, and a little was produced in other districts. It is estimated that about 50 tons of scheelite concentrate was produced in Alaska during 1916, for which the producers received over $50,000.

The production of petroleum from the only oil claims patented in Alaska, in the Katalla district, continued in 1916. The operating company was re-organized and more extensive exploitation was undertaken.

About 8000 tons of coal was mined in Alaska during 1916 from half a dozen small mines. The largest producer was the Bluff Point mine, on Cook inlet, where a lignite bed was exploited for the local market. The mining of coal in the lower end of the Matanuska field, for the use of the Alaska Engineering Commission, was also a significant event. This part of the field is already made accessible by the Government railroad, now under construction. The construction of a private railroad from Bering river into the Bering River coal-field was also begun, and a little coal was mined at the south-west end of the Bering River field. Tenders for leases of coal lands in both the Bering River and Matanuska coal-fields under the new law have been received by the Interior Department. Another important event was the completion by the Geological Survey of a detailed examination of the more accessible part of the Nenana coal-field, lying 60 miles south of Fairbanks. All these facts indicate that systematic exploitation of the Alaska coal-fields will soon be undertaken.

ARIZONA

The output of gold, silver, copper, lead, and zinc from mines in Arizona in 1916 had a record total value of nearly $203,000,000, compared with $90,806,349 for 1915, according to Victor C. Heikes. The notable output of copper and the high prices of metals both assisted in this increase of 123%. There were record productions also of gold, silver, copper, lead, and zinc.

The production of gold from Arizona mines increased from $4,166,025 in 1915 to approximately $4,427,000 in 1916, a gain

of over 6%. The production of gold from copper ores in most counties was naturally greater than in 1915, but there was a marked decrease in the output of bullion from amalgamation and cyanide mills, particularly in Mohave and Maricopa counties. Several new gold mines were added to the list during the year, especially at Oatman, but the production was not sufficient to offset the decline in the output of the older properties.

The production of silver from the mines increased from 5,649,020 oz. in 1915 to a record output of 6,823,000 oz. in 1916. As the market price was much higher, the value increased from $2,864,053 to nearly $4,490,000, an increase of nearly 57% in value. There was no great change in the production from the Commonwealth property, which is principally a silver producer, so the increase is to be credited largely to the remarkable output of copper ore.

The mine output of copper surpassed all records and estimates, as it increased from 459,972,295 lb. in 1915 to approximately 693,000,000 lb. in 1916. The value of the output, on account of the unusual market, increased from $80,495,152 to nearly $190,000,000. The increase of 135% in the value of copper alone in Arizona was therefore more than the value of the total output of the State in the previous year. All the smelting plants of the State were worked at full capacity, and made much greater shipments of copper bullion.

The mine production of lead increased from 21,738,969 lb. in 1915 to a record production of over 26,000,000 lb. in 1916. The value of this output increased from $1,021,732 to $1,768,000, or 73%.

The production of zinc from the mines increased from 18,220,863 lb., valued at $2,259,387, in 1915 to about 20,980,000 lb., valued at $2,874,260 in 1916 an increase of nearly 27% in value. The greater part of the zinc ore and concentrates was shipped from the Golconda and Tennessee properties in Mohave county.

Dividends paid to December 1 amounted to nearly $34,000,000.

CALIFORNIA

The mines of California made an output in gold, silver, copper, lead, and zinc valued in all at $44,384,000 in 1916, compared with $32,263,844 in 1915, according to preliminary figures compiled by Charles G. Yale. This is an increase of $12,120,000 or 38%. Renewed activity has been shown in all branches of metal mining in the State. All the older quartz mines are very active, and a number of new ones have been opened. There is also an apparent tendency to renew drift-mining operations at several points.

The mine figures for gold in 1915 were $22,442,296. The estimates for 1916 indicate an output of $22,939,000, an increase of $497,000, or 6%. The gold yield is the largest in 33 years and, with one exception, the largest in 52 years. The increase is the more notable, because a number of the most productive mines in the Mother Lode section of the State, in Amador county, were closed by labor strikes for nearly 50 days, and the loss entailed by the stoppage of the mills was more than $500,000. There are over 600 productive metal mines in the State, about evenly divided in number between deep and placer properties. From the deep mines the annual output of ore now exceeds 3,000,000 tons. In value of all metals produced, Shasta is the leading county; and in value of gold output Amador, Nevada, Yuba, Sacramento, Butte, Calaveras, Shasta, and Tuolumne, are the leading counties in the order named.

The placer mines of the State continue to produce about 38% of the annual gold yield. The dredges account for 35% of the total gold yield, or 90% of the placer gold yield. There are now 59 dredges at work in the different fields, the most productive of which are in Yuba, Sacramento, and Butte counties. The yield is declining in the Oroville field and fewer boats are at work, some of them on old dredge tailing.

The silver output is estimated at 2,186,500 oz., valued at $1,438,700, an increase compared with 1915, of 508,000 oz. in quantity, and of $588,000, or 69%, in value. The silver is derived mainly from the smelting of copper, lead, and zinc ores, although some silver is recovered also in gold-mining operations.

The estimated mine yield of copper in 1916 is 62,630,000 lb., valued at $17,097,990, compared with 40,751,625 lb. in 1915, an increase of 140% in value.

The estimated yield of lead is 13,755,000 lb., valued at $935,340, an increase in 1916 of 9,176,000 lb., and of $720,000 or 335%, in value.

The estimated zinc output in 1916 is 14,400,000 lb., valued at $1,972,800, which is an increase of 1,306,000 lb., and of $349,140, or 22%, in value, compared with 1915.

COLORADO

The mine output of gold, silver, copper, lead, and zinc in Colorado for 11 months of 1916 and the estimated output for December, according to data compiled by Charles W. Henderson, indicates a yield for the year of $18,940,000 in gold, 7,620,000 oz. of silver, 70,200,000 lb. of lead (in terms of lead in bullion and lead in leaded-zinc oxide), 8,600,000 lb. of copper, and 130,000,000 lb. of zinc (in terms of spelter and zinc in zinc oxide), with a total value of nearly $49,000,000 compared with $22,414,944 in gold, 7,027,972 oz. of silver, 68,810,597 lb. of lead, 7,112,537 lb. of copper, and 104,594,994 lb. of zinc, with a total value of $43,426,697 in 1915. This shows a decrease of nearly $3,475,000 in gold, but increases of 592,000 oz. of silver, 1,390,000 lb. of lead, 1,487,000 lb. of copper, and 25,000,000 lb. of zinc. With the increased average value of metals, the values show increases of $1,451,000 for silver, $1,540,000 for lead, $1,103,000 for copper, and $4,840,000 for zinc.

The tonnage treated by the Globe, Leadville, Pueblo, Durango, and Salida smelters was approximately the same as in 1915, the ore coming from Canada, Colorado, Idaho, South Dakota, and other States, and including a greatly increased quantity of zinc residue from Kansas and Oklahoma zinc smelters. A flotation plant for the treatment of zinc-lead sulphide ores of the San Juan region was built and operated at the Durango smelter during the year. The copper matting plant at Ouray was idle. The United States Zinc Co.'s magnetic wet concentration mill and smelter at Pueblo were actively operated on zinc-lead ores from Colorado and other Western States. The Western zinc-oxide plant at Leadville was operated steadily. The Western Chemical Co.'s acid, magnetic separation, wet-concentration plant, at Denver, was operated steadily at increased capacity, as was the Empire Zinc Co.'s 200-ton magnetic separation plant, at Canon City, both treating chiefly Leadville zinc-lead sulphide ores. The old Rocky Mountain smelter, at Florence, was re-modeled into a plant for the treatment of zinc-lead-copper sulphide ores as an intermediate plant for the River Smelting & Refining Co.'s electrolytic spelter plant at Keokuk, Iowa, and large tonnages of sulphide ores were received from various Colorado counties. Copper ore, copper matte, and cyanide precipitates were shipped to the Omaha smelter, and some copper and lead ores were shipped to Utah plants.

The gold output of Cripple Creek (Teller county) was $11,800,000, a decrease of $1,883,000. Development continued at lower depths with the continued gradual lowering of the water-level as the Roosevelt drainage tunnel was advanced toward the Vindicator-Golden Cycle properties. Experimentation with the flotation process was continued by the Vindicator and Portland companies for the treatment of low-grade mine and dump ore. The Golden Cycle cyanidation mill, at Colorado City, and the Portland cyanidation mills, at Colorado Springs and Victor, were operated steadily, but with a decreased output. The yield from the small cyanide plants in the Cripple Creek district was not so large as usual.

Lake county, chiefly Leadville, but including also the Lackawanna Gulch, Sugar Loaf, and St. Kevin lode districts and

the Arkansas River dredge district, produced $1,760,000 in gold, 3,030,000 oz. of silver, 21,000,000 lb. of lead, 2,600,000 lb. of copper, and 71,000,000 lb. of zinc with a total value of $15,600,000, against $2,246,152 in gold, 2,571,002 oz. silver, 20,957,404 lb. of lead, 1,803,423 lb. of copper, and 72,493,178 lb. of zinc, with a total value of $13,839,401 in 1915. The several ambitious drainage operations by pumping already have resulted in shipments of manganese-silver ore from the Down Town district, and of zinc carbonate from the Fryer Hill district, and the Carbonate Hill drainage will unwater zinc sulphide ores partly developed. The output of zinc carbonate was 106,000 tons of 21.5%, against 82,592 tons of 22.48% in 1915. The zinc sulphide smelting and concentrating ore was 115,000 tons of 21%, as compared with 136,555 tons of 22.09% in 1915. The Derry Ranch dredge, below Malta, continued operations during the year.

The San Juan region of Dolores, La Plata, Ouray, San Juan, and San Miguel counties, produced $3,000,000 in gold, 2,100,000 oz. of silver, 16,000,000 lb. of lead, 2,700,000 lb. of copper, and 5,300,000 lb. of zinc, valued in all at $6,900,000, against $3,834,-521 in gold, 2,278,201 oz. of silver, 14,314,363 lb. of lead, 3,517,-462 lb. of copper, and 1,382,334 lb. of zinc having a total value of $6,210,494 in 1915.

Boulder, Gilpin, and Clear Creek counties produced $1,000,-000 in gold, 830,000 oz. of silver, 5,500,000 lb. of lead, 1,200,000 lb. of copper, and 2,500,000 of zinc, as compared with $1,249,894 in gold, 790,065 oz. of silver, 4,008,744 lb. of lead, 1,094,012 lb. of copper, and 1,516,032 lb. of zinc in 1915. Chaffee county's gold, silver, and lead output fell off, but its copper and zinc yield increased. Pitkin county (Aspen) yielded 570,000 oz. of silver, and 16,600,000 lb. of lead, an increase of 121,000 oz. of silver, but a decrease of 2,700,000 lb. of lead. The yield of Creede (Mineral county) showed improvement over 1915, as did also Gunnison and Hinsdale counties. Summit county's production was $660,000 in gold, 100,000 oz. of silver, 1,400,000 lb. of lead, 14,000 lb. of copper, and 16,000 lb. of zinc, compared with $680,144 in gold, 64,223 oz. of silver, 1,916,298 lb. of lead, and 8,597,411 lb. of zinc in 1915. The four dredges at Breckenridge produced about the same output as in 1915, and the shipments of zinc from Breckenridge increased heavily. There was a revival of mining at Kokomo, Robinson, and Montezuma. Eagle county made the largest output since mining began at Red Cliff, in 1879. The output of zinc was 29,000,000 lb., against 11,141,750 lb. in 1915. The Eagle M. & M. Co.'s magnetic separation wet concentration mill was actively operated on ore from the Iron Mask mine, and large quantities of zinc-lead ores were shipped from the Black Iron mine. The Brush Creek silver district was also active again. Lode mines in Park county made an appreciably increased output, particularly of gold, but the placer output decreased somewhat. The London mine, at the head of Mosquito creek, was the principal producing property.

Custer county mines were more active than they had been for several years, and with the commencement of shipments from the Rawley tunnel, Saguache county's yield promises to show increases. Development work in the Platoro district, Conejos county, seems to promise production in 1917.

IDAHO

The value of the mine output of gold, silver, copper, lead, and zinc in Idaho in 1916, according to C. N. Gerry, was over $47,000,000, an increase of 41% from $33,328,930 in 1915. There was a record output of silver, lead, and zinc and increased production of copper, but a slight decrease in gold.

The mine production of gold decreased from $1,179,731 in 1915 to $1,098,000 in 1916, a decline of 7%. Part of the decrease was due to the smaller placer output from dredging. The gold output from copper ore, lead ore, and lead-zinc ore, however, was increased.

The mine output of silver increased from 11,769,128 oz. in 1915 to approximately 12,500,000 oz. in 1916. As the price of silver was much above that of 1915, the value of the output increased from $5,966,948 to $8,225,000, or 38%. There probably would have been a greater increase in the silver production from lead and lead-zinc ores had it not been for the peculiar smelting conditions during the year, as the Northport smelter, which received the Hercules ore, was being completed, and the Bunker Hill & Sullivan Co. at Kellogg was beginning smelter construction. Each of the following mines produced more than a million ounces of silver: Hercules, Bunker Hill, Morning, Greenhill-Cleveland, Caledonia, and Hecla.

The mine production of copper increased from 6,978,713 lb. in 1915 to over 8,000,000 lb. in 1916. This represents an increase from $1,221,275 to $2,184,000, or 79% in value, due to the better price.

The mine output of lead increased from 345,999,466 lb. in 1915 to approximately 362,000,000 lb. in 1916. The value of the lead output increased from $16,261,975 to $24,616,000, or about 51%.

The mine production of zinc increased from 70,152,234 lb. in 1915 to approximately 80,000,000 lb. in 1916. The value of the output increased from $8,699,001 to about $10,960,000, or 26%.

Incomplete dividends amounted to over $10,600,000.

Preliminary estimates by John D. Northrup indicate that the quantity of crude petroleum produced and marketed in the oil-fields of the United States in 1916 was 292,300,000 bbl. This quantity is greater by 4% than the corresponding output in 1915. Mr. Northrup estimates that 38% of the 1916 total came from the Oklahoma-Kansas field, 30% from California, and the remaining 32% from the Appalachian, Lima-Indiana, Illinois, northern Texas, northern Louisiana, Gulf Coast, and Rocky Mountain fields.

MONTANA

The value of the output of gold, silver, copper, lead, and zinc from Montana mines in 1916 was over $145,000,000, which is greater than that of any past yearly output, and an increase over the previous year of over $62,000,000, or nearly 76%. There were notable increases as well as record outputs in the quantity of silver, copper, lead, and zinc, but a decrease in gold output. These preliminary figures have been prepared by Victor C. Heikes.

The mine output of gold was valued at $4,635,000, a decrease of nearly 14% from $5,400,195 in 1915. Much gold came from the Scratch Gravel district and the Piegan-Gloster mine, in Lewis and Clark county, and from the Ruby Gulch and August, in Phillips county. The production of gold from ores milled, was in several places less than in 1915, and even the gold output from silicious ores smelted seems to be declining. The placer-gold output decreased, especially that from dredge operations, though sluicing was begun below Troy, in Lincoln county.

The mine output of silver in Montana increased from 14,378,-437 in 1915 to 16,686,000 oz. in 1916. The value, on account of better prices, increased from $7,289,868 to $10,979,000, or nearly 51%. Most of this output came from ores and concentrates smelted, especially copper material, in which there was a great increase, but a considerable quantity also came from the lead and zinc concentrate mined at Butte, of which there was a larger production. Work was resumed at the Ophir mine by the Butte Detroit Copper & Zinc Co., and the mill was remodeled.

The mine production of copper, which is Montana's greatest asset, increased from 267,231,014 lb. in 1915 to 357,000,000 lb. in 1916, an increase of nearly 90,000,000 lb. The increase in value was proportionately more, owing to the unusually high price—from $46,765,427 to $97,461,000, an increase of over 108%. Everything was done at both the Anaconda smelters and that of the East Butte company to take advantage of the demand for copper, and at the same time important changes were in progress to improve the output and the

saving. Wages of Butte were increased on a sliding scale making a record pay-roll.

The mine output of lead increased from 13,756,356 lb. in 1915 to a new record of 16,933,000 lb. in 1916. The value of the output was nearly doubled, increasing from $646,549 to over $1,151,000, or 78%. A great part of this output came from lead concentrates made from lead-zinc ore at Butte and from residue resulting from the smelting of zinc concentrates from the Butte district. Part of the lead output came from the Iron Mountain mine, in Mineral county.

The mine output of zinc increased from 187,146,895 lb. in 1915 to 227,000,000 lb. in 1916. In value the output increased from $23,206,215 to $31,099,000, or 34%. The construction of a large electrolytic zinc plant at Great Falls was progressing rapidly, and at the close of the year three units were complete. The plant is to have five units and will make an output of 6,000,000 lb. of zinc per month. A zinc concentration plant having a capacity of 2000 tons was also constructed.

The main dividend payers were the Anaconda Copper and the Butte & Superior companies, but smaller payments were made by the North Butte and Intermountain or Amador. The Barnes King and Kendall gold mines also paid dividends. The available figures show a total of dividends for the year of over $26,000,000, but these figures are not yet complete.

NEVADA

The value of the gold, silver, copper, lead, and zinc from the mines of Nevada in 1916 was approximately $52,475,000, according to Victor C. Heikes. This total represents an increase of nearly $18,000,000, or about 52% above the corresponding figure for 1915, which was $34,551,436. There were large increases, and record productions, made in copper, lead, and zinc, but there was a slight decrease in silver and a large decrease in gold.

The mine output of gold was valued at approximately $9,000,000 in 1916, a decrease of 22% from the output of 1915, which was $11,404,300. The gold output from copper ore was increased, but that from amalgamation and cyanide mills was less in many of the camps. The production of silver was 13,680,000 oz., a decrease from 14,459,840 oz. in 1915. The value of this output, however, on account of the higher price of silver, increased from $7,331,139 to $9,000,000 or 23%. The silver output comes chiefly from the Tonopah district, where there was a marked decrease. In 1915 the district produced 516,337 tons of ore, $2,228,983 in gold, and 10,171,374 oz. of silver. In 1916 the district produced approximately 448,000 tons of ore, $1,941,000 in gold, and 8,884,000 oz. of silver. In the Rochester district there was an increase in both gold and silver production. In the Comstock district there was an increase of approximately 60% in the value of the gold and silver output.

The mine production of copper increased from 68,636,370 lb. in 1915 to over 103,000,000 lb. in 1916. The value of the copper increased from $12,011,365 to $28,120,000, or 134%.

The mine production of lead increased from 16,637,277 lb. in 1915 to 23,466,000 lb. in 1916. The value of the output increased more than $800,000, or 104%, over that of 1915, which was $781,952. A considerable part of this production came, as in former years, from the mines of the Yellow Pine district, in Clark county.

The mine production of zinc was approximately 34,739,000 lb., an increase of over 10,000,000 lb. from that of 1915. There was a greater increase in the value, from $3,022,680 to $4,759,000, or 57%.

Incomplete records of dividends paid by Nevada mining companies during the year amounted to $11,348,000.

NEW MEXICO

The output of New Mexico mines for 11 months of 1916, with an estimate for December, indicates a yield of $1,350,000 in gold, 1,800,000 oz. of silver, 7,100,000 lb. of lead, 91,400,000 lb. of copper, and 36,500,000 lb. of zinc (in terms of spelter and zinc in leaded-zinc oxide), valued in all at $33,469,400, compared with $1,461,105 in gold, 2,005,531 oz. of silver, 4,542,361 lb. of lead, 76,788,366 lb. of copper, and 25,404,064 lb. of zinc, valued in all at $19,279,468 in 1915. These preliminary figures were compiled by Charles W. Henderson.

The Mogollon district, Socorro county (reached at present from the railroad at Silver City, Grant county, 80 miles distant), continued to be the most productive district in New Mexico in output of gold and silver. There was a great deal of new development done, but the yield decreased appreciably.

The Lordsburg district, Grant county, which has been steadily increasing its shipments of silicious gold and silver bearing copper and other ores, again greatly increased its tonnage shipped. The copper concentrates of the Chino Copper Co., containing as they do small quantities of gold, contributed to the gold yield. The continued activity of the mines and matte smelter at San Pedro, Santa Fe county, also added an increased quantity of gold to the New Mexico yield. Shipments of copper ores from the Jarilla district, Otero county, carried some gold.

The principal metal produced in New Mexico is copper, and since 1910 the yield has been chiefly from the Chino Copper Co.'s low-grade copper deposits at Santa Rita. The ore is milled at Hurley in a large wet-concentration-flotation plant. During 1916 the largest tonnage in the history of the company was treated and the gross output was 75,500,000 lb. The Burro Mountain Copper Co.'s new concentrator began operations in April and started running at full capacity June 1, 1916. The Santa Fe Gold & Copper Co.'s 125-ton matting plant, at San Pedro, added a considerable quantity of copper to the output. Copper ores were also shipped from the Organ Mountain district, Dona Ana county.

The yield of lead showed an appreciable increase. Lead ores were shipped from the Central, San Simon, and Pinos Altos districts, Grant county, and Cooks Peak and Victorio districts, Luna county. Considerable tonnages of lead carbonate ore were shipped from Kelly, Socorro county.

Increased shipments of zinc carbonate and sulphide ores and zinc sulphide were made in New Mexico in 1916. At Kelly, Socorro county, the principal producing mines were the Kelly, Graphic, and Juanita.

OREGON

Preliminary estimates compiled by Charles G. Yale of the San Francisco office of the Survey show increases over 1915 for gold, silver, and copper, and a decrease for lead. The output of gold in 1915 was $1,861,796 and for 1916 $1,900,000, an increase of $38,000. The output of silver in 1915 was 117,947 oz., and in 1916 227,500 oz. The output of copper in 1915 was 451,172 lb., and in 1916, 2,527,000 lb., and the output of lead in 1915 was 62,957 lb., compared with 22,000 lb. in 1916. The increase in gold is merely nominal, but that of silver has about doubled. The most notable increase is in the quantity of copper, an increase caused by the incentive offered by high prices. There are less than 100 productive metal mines in Oregon, and the number of placers is about double that of the deep mines. However, two-thirds of the gold output and virtually all that of the other metals, is derived from deep mines. No very productive new properties have been opened during the year. The entire output of the deep mines is derived from less than 160,000 tons of ore, having an average value of about $9 per ton. Baker is still the most productive county in the State, yielding annually nearly 90% of all the gold. The Cornucopia and the Baker mines, in the Cornucopia district, Baker county, are the most productive deep mines in Oregon. Other large deep mines in Baker county are those of the Commercial Mining Co. (Rainbow mine), at Rye Valley, in the Mormon Basin district; the Columbia Gold Mines Co. at Sumpter, Cracker Creek district; and the Homestead-Iron Dyke property, at Copperfield, Iron Dyke district. The Powder River Dredge Co., operating two boats near Sumpter, Cracker

Creek district, is the most productive placer mining enterprise in the State. In 1916 a new dredge was under construction in the John Day Valley, Grant county. The most productive hydraulic mine in Oregon is that on the property of the Columbia Mines Co., in Placer district, Josephine county. Other notably productive hydraulic mines are the Martin & Daniels, Galice district, Josephine county, and the Sterling, in Forest Creek district, Jackson county. The gold won by dredging far exceeds that obtained by all other forms of placer mining combined.

SOUTH DAKOTA

The production of gold from mines in South Dakota in 1916 was $7,463,000, compared with $7,406,305 in 1915, and that of silver was 209,000 oz., compared with 199,864 oz. in 1915. A nominal quantity of lead was produced. These are preliminary estimates reported by Charles W. Henderson.

The Homestake mine and amalgamation-cyanidation mills were operated continuously throughout the year with an increased output. All the other cyanidation mills in Lawrence county were operated steadily, with the exception of Bismarck. During a part of the year the Deadwood-Standard cyanidation mill was also operated on ore from the Slavonia property.

A small production of placer gold was made in Custer, Lawrence, and Pennington counties. A small yield of lode gold was made from the Hill City district, Pennington county, and considerable development was done in the Keystone district and several small shipments were made.

TEXAS

The output of Texas mines for 11 months of 1916 with the estimated output for December, as shown by preliminary figures reported by Charles W. Henderson, amounted to $600 in gold, 680,000 oz. of silver, 50,000 lb. of lead, and 100,000 lb. of copper, compared with $1503 in gold, 675,473 oz. of silver, 219,298 lb. of lead, and 42,491 lb. of copper in 1915. The greater part of the output of silver came from the Presidio silver mine and cyanidation mill, in the Shafter district, Presidio county.

UTAH

Utah mines will close the year 1916 with a record-breaking ore output of gold, silver, copper, lead, and zinc having a total value of about $97,000,000, as estimated by Victor C. Heikes. This record indicates an increase of nearly 77%, or $42,000,000 over the output of 1915. All the metals showed increases and there were record outputs of copper, lead, and zinc. About 14,000,000 tons of ore was mined in 1916, against 10,451,445 tons in 1915. The mines at Bingham produced the larger part of this ore, or nearly 13,000,000 tons, mostly by steam-shovel mining. This quantity includes about 12,000,000 tons of disseminated copper ore, the output of which in 1915 amounted to 8,908,567 tons. In all districts many of the old mine and tailing dumps were re-worked or shipped directly to the smelters. Ore shipments from the Tintic district totaled about 400,000 tons, representing an increase of 36% over 1915. The estimate includes a quantity of oxidized iron ore greater than that shipped in any previous year, caused by the demand for flux at the different smelters. Several thousand tons of ore and old dump material that are not included in the estimate were milled in the district. In the Cottonwood and American Fork districts over 47,000 tons of ore of shipping grade was produced in 1916. Nearly half the output was hauled by wagon and tractor-engines down Big Cottonwood canyon to the valley furnaces. The Park City region produced less milling ore and more ore of shipping grade, which, with concentrates from three ore mills and two large tailing plants, amounted to nearly 90,000 tons, a decrease of about 7500 tons from the output of 1915. In 1916 two new mills were erected at Frisco and Newhouse, in Beaver county, to work tailing yielding copper, lead, and zinc concentrates, which, with the ore shipped from the different mines, aggregated 65,000 tons. This is an increase of more than 46,000 tons over 1915. The ore output in Tooele county, principally at Ophir and the Stockton camps, including the smaller districts, North Tintic, Columbia, Dugway, and Erickson, amounted to 126,000 tons. This included the milling ore of the Ophir and Bullion Coalition properties. There was an increase of 14,000 tons of ore compared with 1915.

The gold output of Utah shows a slight increase, from $3,609,109 in 1915 to $3,647,000 in 1916.

The production of silver is 8% greater, increasing from 12,313,205 oz. to 13,357,000 oz., amounting to an increase in value of over $2,500,000.

Copper production in Utah broke all records, increasing from 187,671,188 to 242,000,000 lb., an increase of 29% in quantity and over $33,000,000 in value. The gigantic operations by steam-shovel at the great mine of the Utah Copper Co., kept two railroad lines busy hauling an average of 31,000 tons of ore daily to its two concentration mills at Garfield, 15 miles distant. There were days when the ore hauled exceeded 40,000 tons. At Lark, the Ohio Copper mill operated on low-grade copper ores from its mine, which was in the hands of lessees.

Lead production also surpassed all former records, increasing from 199,967,437 to over 215,000,000 lb., the increase amounting to about 7% in quantity and over $5,000,000 in value.

Prices for zinc continued high during the early part of the year, and much ore and concentrate containing the metal was marketed, but the price broke in May and was low in June, when a general falling off of the production was noticeable until the markets became settled. Altogether there was produced about 29,000,000 lb. of metallic zinc by 39 producers, against 24,292,240 lb. by 34 producers in 1915. The increase in value was nearly $1,000,000. No new zinc districts were opened in 1916.

Dividends were paid by 22 mining companies, amounting to about $24,404,320, as against $9,827,524 in 1915.

WASHINGTON

The value of the mine output of gold, silver, copper, lead, and zinc in Washington increased from $744,033 in 1915 to approximately $2,018,000 in 1916, according to the preliminary estimates of C. N. Gerry. This is the record output of the State in value.

The mine production of gold increased from $391,419 in 1915 to $540,000 in 1916. The greater part of the gold was derived from the silicious ore shipped to smelters from the Republic district of Ferry county. The cyanide mills were not operated. The silver output of Washington mines increased from 255,837 oz. in 1915 to about 315,000 oz. in 1916.

The mine output of copper increased from 1,020,926 lb. in 1915 to about 2,569,000 lb. in 1916. Since the average price of copper was more than 27c. per pound in 1916, the value of the copper increased from $178,662 to over $701,000. Thus copper is now of more importance than gold, which was formerly the principal metal of the State. A large part of the copper output came from the Chewelah district.

The mine production of lead increased from 295,215 lb. to about 4,937,000 lb. The value of the output increased from $13,875 to about $336,000. This notable increase was due largely to the discovery of lead at the Electric Point mine, near Northport.

The mine output of zinc increased from 244,906 lb. to 1,709,000 lb., an increase of nearly 600%.

PORTLAND CEMENT manufactured in the United States during 1916 amounted to 91,194,000 bbl., an increase of 5,000,000 bbl Stocks declined over 3,000,000 bbl. Prices averaged higher and trade conditions were generally better than in 1915; the outlook for 1917 is considered good.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

ROCHESTER, NEVADA

WAGES RAISED.—NEW DEVELOPMENTS AND IMPROVEMENTS.

All of the companies in the Rochester district have increased wages 50c. per day. The increase was granted voluntarily, conditional on silver remaining above 70c. per ounce. The new wage-scale is as follows: Blacksmiths, $5.50; miners and timber-men, $5; trammers, muckers, and helpers, $4.50. The standard rate for board remains at $35 per month, with $1 additional for medical and hospital fee.

At last the high price of silver is having its effect on this district; there is more work being done now than at any previous time. It is encouraging to note that much of the new development is being undertaken on the advice of well-known engineers and geologists, and that the flamboyant publicity that marked the early period of the district's history is much less in evidence.

One of the largest deals is now being carried through by Joe Colligan. It involves the bonding or purchase of all the properties lying between the Rochester Mines property and the Packard, over 25 claims in all, including the Packard North Extension, Shepherd, Cold Storage, Enterprise, Jackson, Rochester-Packard Annex Co., and probably the Packard South Extension. There are persistent rumors that the Friedman interests are back of the deal.

The addition to the Rochester mill is not yet completed, shipments of machinery having been delayed. Work on the new tramway commenced December 1. The company announced that it would be completed in 60 days or less. It is to be nearly three miles long, constructed during a period of frequent snow-storms, so that this estimate of time seems rather optimistic. The company developed abundant water at Hardesty springs during the summer, so the mill will not have to face the shortage that curtailed production a year ago. Practically all ore is now being drawn through the Friedman tunnel, eliminating the haulage on the hill tram.

The Merger company has started sinking an incline shaft on a strong vein outcropping on the crest of Nenzel hill, a few feet from the Rochester Mines east side-lines. This is probably destined to have an important bearing on the future work here. The Merger intends to begin the erection of a 100-ton mill in the spring. Sufficient water is available in American canyon, and the company expects to have a surplus to partly fill the needs of the town of Rochester, which is as yet unsupplied with water.——The Nenzel Crown Point is pressing development, and the Elda Fino will begin operations early in the new year. These three companies will work in close harmony and much of their development will be done jointly.

To develop the Octopus ground, a half mile from the Rochester Mines mill, the Rochester Octopus Mines Co. has been organized by Nevada and Utah people. The output so far is 700 tons of $32.54 ore.

The new refinery of the Packard mill was completed late in December. Concentrate was formerly shipped to the Selby smelter. Specimen ore containing ruby silver, as well as horn silver, is being taken from the recently encountered Kromer-Hampton vein. This vein is undoubtedly the source of the rich surface ore shipped from the Kromer-Hampton lease. A large quantity of ore has been blocked-out on the contact orebody. Jay A. Carpenter is general superintendent.

Some fair ore has been found in the Rochester United.

CASPER, WYOMING

ENCOURAGING OIL DEVELOPMENT IN BIG MUDDY FIELD.

Recent developments in the Big Muddy field have been such as to attract the attention of oil operators and investors from far and near. Big Muddy looms on the horizon as an embryo oil-dome of great promise, and its development along the broad lines now outlined, will, it is confidently believed, within the next few months result in very large production.

Less than a year ago—in fact during the early months of 1916—the first well was started and oil shortly after was discovered in the Shannon sand at a depth of about 1000 ft. This work was done in the face of adverse reports on the possibilities of the structure by many well-informed oil geologists. Only on man, V. H. Barnett, of the U. S. Geological Survey, was willing to stake his reputation. In Bulletin 581-C he discussed the probabilities and possibilities of finding oil in the Wall Creek sandstone, a series productive of good oil in large quantities in the Salt Creek field 50 miles north-west, and which he found to outcrop along the south side of the Big Muddy areas. Although his report was published in 1914, the contradictory contentions of other geologists delayed the starting of drilling.

However, the finding of the first oil was sufficient to encourage further work, and additional rigs were erected on the field. Early results were flattering, which, while determining the Shannon sand to be 'spotted,' developed a number of productive wells. In the meantime three drills had been started for the Wall Creek sand. One of these was erected by the Merritt Oil & Gas Co., another by the Whitesides Co., and the third by the Midwest Refining Co. The Merritt well was the first drilled-in. The Wall Creek sand was encountered at a depth of 3150 ft., and after drilling 16 ft. into the oil-bearing stratum, work was suspended pending the installation of tankage and equipment for caring for the production. This well is now flowing 175 bbl. daily, and it is believed that further drilling will greatly increase the yield. The Wall Creek sand is 125 ft. thick, and an admirable oil container—hence the predictions of greater production.

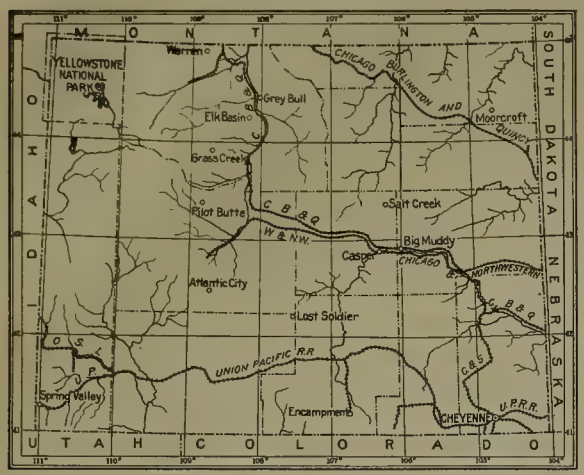
Various troubles were encountered at the Whitesides well, one hole was abandoned at a depth of over 1900 ft., another was lost, and work is now going forward on the third attempt to reach the deep sand. Satisfactory progress has been made at the Midwest well, and it is expected to reach the big sand late in December.

In the meantime at least 25 wells have been finished to the Shannon sand, and are producing 25 to 50 bbl. each; while 10 others have not been productive of oil. At present more than 25 rigs are at work in the field, and recent contracts made by the Midwest, Ohio, and other strong companies call for many additional rigs soon to be engaged in development. High prices have been paid for choice holdings, now that oil has been found, and even the New York Curb has interested itself.

Probably the largest single transaction yet recorded has been the organization of the Merritt Oil Corporation, which has secured the leases and holdings of the original Merritt company and several adjoining tracts. It has been capitalized at 600,000 shares of $10 par value, and in the first few days of trading on the New York Curb changed hands at prices well above par. It is understood that the Midwest company purchased half of the capital stock at a price of $2,500,000. Other

important transactions have been the purchase of a half-interest in the Kinney lease—400 acres of school land—by the Ohio Oil Co. for a consideration of $100,000, and a purchase of one-half of the Elkhorn, by the Midwest, for $25,000. Subsequent to the Merritt strike—the deal mentioned was made prior to that important find—the Midwest has offered $250,000 for the other half. The owners want $300,000, a price the big company has under consideration and may accept.

Big Muddy is favorably situated. It is 20 miles east of Casper, on both the Burlington and Northwestern railways. The present production, except that used as fuel under the



MAP OF WYOMING. EXCEPTING ATLANTIC AND ENCAMPMENT, THE OTHER CENTRES ARE OIL PRODUCERS.

boilers of the drilling rigs working in the field, is shipped by rail to the refinery at this point. There is talk of constructing a refinery at the field, for, although the Midwest is increasing its facilities at Casper, the production will soon exceed the capacity of the plant.

Pilot Butte, Dallas, Lost Soldier, and Brenning have been recent points of oil discovery, while production continues at Salt Creek, Grass Creek, Greybull, Lander, and Hudson. Central Wyoming, with Casper as the logical trading point and centre of activity, will next summer be the scene of further important discoveries. Scouts are working in greater numbers, and almost daily rigs are loaded and hauled to strategic locations "somewhere in the sagebrush."

Wyoming's production of crude oil in 1916 will exceed 7,000,000 bbl. With many wells capped, it is not a far cry to the projected pipe-line to Omaha, Nebraska. In fact, that may be a reality almost before we know it.

TORONTO, ONTARIO

COPPER IN MANITOBA.—MOLYBDENITE IN QUEBEC.—PORCUPINE, BOSTON CREEK, AND COBALT NOTES.

The requirements of munition manufacturers have given a great stimulus to the production of copper, zinc, and molybdenum, as well as to the steel industry, and many deposits of these metals, formerly regarded as commercially unavailable, are now being worked. The copper deposit on Schist lake north of The Pas, Manitoba, after having been thoroughly proved by diamond-drilling, is being exploited by the Tonopah Mining Co., which is arranging to take out at least 5000 tons of ore during the winter. It will be hauled for 38 miles to Sturgeon portage, from which it will be conveyed by water to The Pas, and shipped to the smelter at Trail, B. C. The company has placed extensive orders for machinery.——The Mine Centre Copper Co., which holds eight claims near Mine Centre in the Port Arthur district of Ontario, has shipped six cars to the Trail smelter, the returns from which have been so satisfactory that it has been decided to instal a concentrator during the winter.——On the Mathews property adjoining surface showings indicate a continuance of the vein, and active development is being undertaken.

The demand for molybdenite has produced something like a boom in the staking-out of molybdenite claims in the Quyon, Quebec, district, where there are extensive showings of that mineral. One mine, owned by the Canadian Woods Molybdenite Co., is in operation, producing 180 tons of ore per day. The ore realizes $30 per ton net. After being separated from the rock, at Renfrew or Ottawa, it is sent to Kingston to be refined, and the finished article turned over to the Government for shipment to England. The deposit is low grade, but nearly all the ore is good enough for milling. Many other claims are being tested with a view to speedy development.

The merger of the McIntyre, McIntyre Extension, and Jupiter mining companies of Porcupine has been arranged, and the terms will be submitted to the shareholders of the McIntyre for ratification on December 28. The Extension is to receive 294,000 McIntyre shares, which is equivalent to 1 share for every 3¼ shares of McIntyre Extension outstanding other than already owned by the McIntyre. For the Jupiter the price is 316,298 McIntyre shares, equal to 1 share for every 3 Jupiter shares, exclusive of those held by the McIntyre.——There has been some delay in the construction of the addition to the Hollinger mill owing to labor shortage, but the building is now nearly complete and installation of the machinery will shortly be started. It is expected to be in operation by June next. The Hollinger is now treating 1900 tons per day, and the addition will almost duplicate its capacity. At the Apex diamond-drilling has been started. The main shaft, now down 125 ft., will be sunk to the 300-ft. level, at which cross-cuts will be made to tap veins coming in from the West Dome and Dome Lake.——The Thompson-Krist has let contracts for diamond-drilling to begin early in January. ——Diamond-drilling at the Inspiration has reached a depth of 285 ft., the cores showing heavy mineralization.——At the Newray a test pit has been put down 21 ft. on the west side, and assays are stated to give $36 per ton.——Development of the vein found south of the shaft on the 100-ft. level of the Schumacher shows the high-grade body to be larger than was supposed. Nearly 200 ft. of driving has been done, the vein widening about 12 ft. with an ore-shoot 75 ft. long and 6 ft. wide, stated to be worth $50 per ton.

At Boston Creek, the Boston Creek Mines is pushing development, having had 50 men at work since May of last year. An incline shaft is down 200 ft., and over 800 ft. of driving and cross-cutting has been done. A winze will be sunk 1000 ft. from the 200-ft. level, and a raise made to the surface to make a new vertical 3-compartment shaft. Rich ore is being taken from the 100-ft. level, where the vein is 12 ft. wide.

The Dominion Reduction Co. has bought a controlling interest in the Caswell property at West Shining Tree, where several rich veins have been found. In one of these at a depth of 20 ft. there is a gold showing 2 in. wide.

At Cobalt the McKinley-Darragh company has placed an order for a new ball-mill, which will take the place of the present 50-stamp mill.——The Buffalo company will install a new 600-ton smelter, the machinery for which was ordered some time ago, but delivery has been delayed.

Dividends paid at Cobalt in 1916 totaled $4,958,651. Of this, the Beaver contributed $60,000; Coniagas, $600,000; Kerr Lake, $600,000; La Rose, $299,725; Mining Corporation of Canada, $570,615; McKinley-Darragh-Savage, $269,723; Nipissing, $1,500,000; Peterson Lake, $168,127; Right of Way, $16,855; Seneca Superior, $598,605; Timiskaming, $225,000; and Trethewey, $50,000. The total to date of all companies that have operated at Cobalt is $67,318,853.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

JUNEAU. After over a 5 months' tour of the interior, the Territorial mine inspector, W. Maloney, states that the past season was a good one in all districts. Water was short at first, but after the rain there was plenty. At Nome the Pioneer Mining Co.'s hydraulicking yielded $200,000 in one clean-up. The Marshall district is promising on one creek. From Iditarod to Ruby there are 500 prospectors busy.

VALDEZ. The last clean-up of the Granite Gold Mining Co. netted between $11,000 and $12,000. In addition there are six tons of concentrate estimated at $174 per ton, that are not included. "The mine is looking better than ever," says the manager, W. R. Millard. The shoot on the 110-ft. level is much stronger than on the 50-ft. level, and the end has not been reached.

Telegraph advice states that a large part of Valdez was destroyed by fire on January 2. Intense cold hampered salvage operations.

WRANGELL. According to J. G. Galvin, general manager of the Bon Alaska Mining Co., who has gone to Seattle to purchase equipment, winter work will be of a preparatory nature. Roads have already been constructed and camps established. High-grade galena has been opened in the Lake group of claims, the vein being 5 ft. wide with good walls. In Groundhog basin, 4 miles inland, a 200-ft. adit has been driven, also trenching on the surface for 3000 ft. The lodes are from 5 to 10 ft. wide. A hydro-electric plant is to be erected at once. Bunkers, etc., will be built on the beach for ore shipments.

ARIZONA

CHLORIDE. The output of this district in 1916 is estimated at $12,000,000. Of this, $10,000,000 came from the Tennessee mine. Forty mines are now being worked, 12 others are to begin soon. Three mills of a total of 600-ton capacity are being constructed; two others and a sampling-plant are probable. Railroad business has increased over four times.

DOUGLAS. The population of this centre is 26,100, a large gain during the past year. The town depends on a cultivated valley and two copper smelters—the Copper Queen and Calumet & Arizona. It is a meeting place in the South-west for mining men, and may be an important railroad junction. Across the border in Sonora are large mining regions tributary to Douglas, all helping business there. The *Douglas Daily Despatch* recently published some interesting facts on the smelter town.

OATMAN. Development in the Gold Road Bonanza mentioned last week, was on the 500-ft. level, where a vein was cut by the shaft. Sinking will be continued until the shoot leaves the shaft. Assays yielded $5.79, $13.05, $27, and $41.79 per ton.

PARKER. In its press bulletin the Parker Bureau of Mines describes conditions in the district, where many large bodies of gold and copper ore have been opened. In the eastern end the Clara Consolidated is shipping several carloads of ore daily, the monthly output being $60,000. Most of this comes from the 400-ft. level.——Adjoining Clara is the Arizona Revenue Copper Co., a recent consolidation of properties that have good possibilities. On the Echo claims 1500 ft. of work has been done, exposing rich copper ore. The Revenue and Elephant claims also show good ore.——North of the Arizona Revenue property is the Planet mine, controlled by the Lewisohns. A shaft is down 500 ft. Churn and diamond-drilling results were good. Lessees have the right to mine to a shallow depth, and keep 8 auto-trucks busy carrying ore. Their profit in 6 months is said to be $200,000.——Other promising properties in the district are the Mexican, Mineral Hill, Continental, Mohawk Con., Pride, Mammon, Empire, and Arizona McGinnis.——A 75-ton mill is being erected for the Billy Mack company.——The Swansea smelter, of 750 to 1000-ton capacity, is still idle, though rumors say that it may soon be blown-in again.——Arrangements have been made and plans are well under way for the installation of a power-plant at Parker to supply the entire district, using oil for fuel, until water-power can be developed from the Colorado river. This plant will probably be started within a few weeks and be rushed to completion, the financing having already been arranged for.

(Special Correspondence.)—The Mile Wide Copper Co., in the Tucson mountains, is to start a 6000-ft. tunnel connecting the Alta valley with the Santa Cruz Valley side of the range. This will reduce the distance of hauling ore and supplies to railroad from 18 to 5 miles. The tunnel will also cut 9 distinct contacts that are exposed on the surface. A Fairbanks-Morse 100-hp. oil-engine and Sullivan angle-type compressor are being installed. This will help exploration on the 200-ft. level. A complete topographical and geological map is being made of the property by W. J. Bloch, assistant superintendent.

Tucson, December 21.

WICKENBURG. The Arizona Sampling & Reduction Co. is erecting a sampling plant here that is almost ready for operation. There is 1800 tons of ore, mostly copper, awaiting sampling. Two Snyder and two Vezin machines do the sampling. In the 50-ton treatment plant there is a Marcy ball-mill, Akins classifier, Wilfley tables, and flotation cells.

ARKANSAS

YELLVILLE. The North Arkansas zinc region produced 93 carloads of ore during November, a record. This is equal to 3000 tons, worth $65 per ton, or $195,000.

CALIFORNIA

BISHOP. The Last Burro mine in the Ubehebe district, near the Nevada border, has been taken over by C. E. Knox of the Montana Tonopah company. A hoist, mill, and houses are being erected. Much of the material was shipped in from Los Angeles by way of Bonnie Claire, the nearest railroad point, and then transported to the mine with the aid of a Yuba tractor of the caterpillar type. The mine is 52 miles west of Bonnie Claire. George F. Badgett of Tonopah will have charge of the work. The Lost Burro is said to be in condition for shipping.

(Special Correspondence.)—The owners of the McKean mine in Siskiyou county are negotiating for the Dressler property at the head of Eagle creek in Trinity county, 7 miles distant. Dressler & Ingram are the owners of the property, which comprises two well-developed claims. There is a strong vein of high-grade sulphide ore that is amenable to cyanidation. The owners of the Yellow Rose, which adjoins the Doraleska and is situated partly in Trinity county and partly in Siskiyou, will drive a lower adit next year to reach the rich ore-shoot discovered in the upper workings years ago. This shoot yielded ore in 1902 that milled $18 per ton and shipping ore

that gave $1600. It has a serpentine-porphyry contact, the hanging wall being porphyry and the foot-wall serpentine. The new adit will be 400 ft. long and will give 150 ft. additional backs.——The Jubilee mine has been shut-down for the season, but will resume in the spring as early as the weather permits. The cause of the shut-down was the freezing of the water in the ditch, but that will be remedied this coming year. The ditch will be widened and a flume or pipe-line built part of the way. It will be widened sufficiently to supply the 150-hp. electric plant that is to be built in the coming summer. The compressor and mill will be operated electrically instead of by water; also the ore-cars. The lower adit, No. 5, is in 300 ft., and will be continued until the ore-shoot of No. 4 adit is encountered. It will be the main working outlet. At a distance of 750 ft. from the portal a 4-ft. vein of commercial ore was cut. The Jubilee ore contains telluride. Laboratory tests give 97% extraction. The ore of Poeth mine, which adjoins the Jubilee and is also under bond to the California Extraction Co., is likewise a telluride ore, and gives a laboratory extraction of 95%. The mill is equipped with 10 stamps, to which will be added a tube-mill. The Vandercook process will be used, in which amalgamation precedes cyanidation. Herbert E. Noll is superintendent and John Botticher foreman.

Coffee, December 13.

(Special Correspondence.)—The work of installing the plant of the Grass Valley Consolidated Mines Co. at the Allison Ranch mine is now over 70% complete, the various units being mostly under cover. Owing to slow freight shipment, the transformers are not here, delaying unwatering; but the large centrifugal pump, with a capacity of 1000 gal. per minute, is in place. The water already has been lowered over 100 ft. by the siphon method. Work on the electric tramway, which will connect the head-frame with the ore-bins, high on the bluff above the stamp-mill, is under way. By the time the plant is ready to operate the company will have expended approximately $110,000, exclusive of the purchase prices of the Allison Ranch and adjoining properties.

PLANT UNDER CONSTRUCTION AT THE ALLISON RANCH MINE, GRASS VALLEY.

Grass Valley, December 23.

Redding. Next spring L. Gardella is to build another dredge on Clear creek, moving one from Oroville.

(Special Correspondence.)—The Central Eureka Mining Co. has issued its November report, showing that work was resumed at the mines on the 6th, and 20 stamps of the 40-stamp mill began crushing on the 20th. There was treated 1781 tons of ore, which yielded bullion $2217, and 37 tons of concentrate $2730. There was collected on assessment No. 39, $7178. The total income was $12,142. Out of this the expenditure was $10,487.

The treasury has a balance of $8264. Sinking the shaft from 3200 ft. for 150 ft. commenced on November 20; good progress is being made. Development and ore extraction is under way on the 1800, 2700, 2825, 3000, 3100, and 3200-ft. levels. The new hammer-drills in use in the 1800-ft. west cross-cut are doing good work. The tailing reservoir was reinforced during the month, and the flume trestle thoroughly overhauled and graded, as it had settled at some points.

Preparations are well under way for sinking the Bunker Hill shaft an additional 600 ft., this work to start early in January. Indications on the lower levels are excellent for the development of large reserves of high-grade ore below the 2400-ft., which is now the lowest level. Until the strike occurred in September, the Bunker Hill had not missed a single monthly dividend for nearly nine years, and with the shaft extended to the 3000-ft. level, there is reason to expect not only the resumption of dividend-payments on a generous scale, but the building up of a large surplus as well. The permanent shaft repairs and surface improvements recently made have brought working costs down to a low figure. The following prominent Amador County men are the officers of this company: W. F. Detert, president; E. C. Voorheis, vice-president; Benj. F. Taylor, Arthur Goodall, and Chas. L. Culbert, directors; and E. Hampton, secretary and superintendent.

A new pump has been installed and the shaft crew increased at the Hardenburg mine, south of Jackson. The W. J. Loring Co. is the present operator.

Immediately after Christmas, operations are to be resumed at the Poundstone or Rose mine, a mile east of Sutter Creek. San Franciscans and a Mr. Stone of Goldfield, Nevada, have taken an option on the property, and have agreed to sink the main working-shaft 1000 ft. If good ore is found while doing this, the new company will build a mill and sink a new shaft for further development. L. R. Poundstone of Grimes, Colusa county, is the owner, and he has had just enough men employed since the cessation of operations a few months ago to keep the shaft unwatered. Besides a 20-stamp mill, the Poundstone property is equipped with a small hoist and the usual mining machinery.

Sutter Creek, December 24.

IDAHO

Dividends paid by companies in the Coeur d'Alene region were as under:

Company	1916	1915	To date
Bunker Hill & Sullivan	$1,726,750	$1,062,750	$18,489,750
Caledonia	911,750	677,300	1,794,481
Federal	510,000	480,000	15,795,495
Hecla	1,555,000	565,000	5,305,000
Hercules	3,000,000	2,250,000	10,250,000
Interstate-Callahan	2,789,940	2,557,445	5,347,385
Intermountain	16,208	.....	16,208
Stewart	.....	804,934	1,981,507
Success	345,000	555,000	2,173,000
Tamarack & Custer	71,050	.....	71,050
Total	$10,925,698	$8,952,429	$61,223,876

HAILEY. The Federal Mining & Smelting Co. is shipping concentrate from its North Star mill in the Wood River district to Colorado smelters. The ore is complex, containing lead, zinc, silver, gold, and iron, and its treatment is now on a satisfactory basis.

WALLACE. The firm of Twohy Bros. of Portland, Oregon, has been awarded the contract to construct a railway up Pine creek for the Oregon-Washington Railroad & Navigation Co. The line will run from the road at the mouth of the creek to the Constitution mine, 10 miles. The three largest mines in the Pine Creek district are the Highland-Surprise, Douglas, and Constitution. Others are developing well.

During the quarter ended October 31, 1916, the Federal Mining & Smelting Co. at Wallace shipped 35,304 tons of ore and concentrate. The profit was $410,007, less $64,363 for depreciation.

MISSOURI

JOPLIN. Zinc-ore prices declined again last week, a total of $25 per ton in three weeks. The output of the Missouri-Kansas-Oklahoma region was 6164 tons of blende, 232 tons of calamine, and 847 tons of lead, averaging $80, $45, and $90 per ton, respectively. The total value was $596,682.

NEVADA

On Sunday, December 24, a storm in the White mountains of California destroyed several miles of transmission-lines and towers owned by the Nevada-California Power Co., which supplies Goldfield, Tonopah, and other mining districts. In the meantime all power and light was cut off. Connection was established again on Thursday, the 28th. Owing to the trouble Tonopah mines only treated 3431 tons of ore, valued at $68,620, about 30% of the normal weekly output. Water rose considerably in the Extension mine, but the electric pumps will soon move this. The Belmont shipped 112,558 oz. of bullion. During the year ended September 30, 1916, the Jim Butler Tonopah Mining Co.'s output was 11,637 oz. of gold and 1,055,235 oz. of silver, from 46,489 tons of ore. Dividends totaled $343,604. Ore reserves are estimated at 19,158 tons.

GOLDFIELD. Final figures of the Goldfield Consolidated for November show that the profit from 30,000 tons of ore was $15,137. The cost was $4.54 per ton, including 4c. for filter and 4c. for flotation royalty. Development covered 1705 ft., costing $5.63 per foot.

(Special Correspondence.)—Construction of the Boss Mining Co.'s 10-ton mill has been practically completed, and it is scheduled to go into commission about January 15. Delays in securing equipment from Los Angeles prevented an earlier start. Considerable copper-bearing ore is being developed, the product containing some gold and platinum. R. J. Goodwin is in charge of the plant.——Work at the Boss Extension is proceeding. The tunnel is in 250 ft., and the shaft is now 40 ft. deep. It is near the side-line of the Boss mine. Some fair ore has been encountered, and A. E. Buys and Nicholas Kunz, two of the largest owners, are directing work.

John A. Egger has been appointed superintendent of the Oro Amigo, which has recently developed into one of the best properties of the district. A good tonnage of profitable ore is on the dumps and blocked-out underground, and preparations are being made for regular shipments. Besides good copper and silver-content, the ore contains platinum, gold, and palladium. ——The Knickerbocker and Poppy claims, adjoining the Oro Amigo, have been acquired by the Poppy-Knickerbocker Platinum Mining Co., controlled largely by Henry Robbins of Pasadena, California, and Joseph Sanders, H. K. Riddall, and Otto F. Schwartz of Goodsprings. Good ore is indicated and development will be pushed. The property lies near the Keystone group, formerly a noted gold producer.

Heavy shipments of silver-lead-zinc ore are going out from the Yellow Pine mine, and the new reduction plant is operating satisfactorily. The Christmas Consolidated Co. has started developments on the Mt. Queen mine, where ore containing lead and some vanadium was lately found.

Developments throughout the district are extensive, with numerous companies on the shipping list.

Goodsprings, December 20.

TONOPAH. Some fast work was done recently on the 850-ft. level of the Monarch-Pittsburg mine, where 101 ft. was driven in 7 days. Three shifts employed one machine-man and one shoveler. This drift is to make a connection that will improve ventilation and enable rapid development of an ore-shoot.

YERINGTON. The Nevada-Douglas company is employing 300 men at its mines and treatment plant.

NEW MEXICO

(Special Correspondence.)—During the first half of December the Socorro M. & M. Co. produced 14,000 oz. of gold-silver bullion.——The Mogollon M. Co.'s product for the same period was 10,000 oz. of bullion, with several tons of high-grade concentrate.

The head-frame at the Pacific mine has been raised, permitting dumping of the ore direct into the new crushing plant. The new aerial tram to the Socorro mill is in regular operation.

The Myrtle shaft has been re-timbered by the Oaks company, and sinking is now in progress. The showing justifies the belief that milling ore will be encountered in the near future. Myrtle adjoins Maud S, and is a continuation of the Deep Down-Maud S vein, which has an accredited production of $1,000,000. The Maud S, closed for 18 years, flourished in the early days of pan amalgamation and operated on a high grade of ore which, in spite of the then high extraction losses, made a handsome profit. It is understood that the mine contains a large tonnage of what was passed over in those days as second-grade ore.

Mogollon, Deceember 19.

OREGON

HUNTINGTON. The Conner Creek Mining Co., which has been mining $6 to $8 ore for two years, crushing it in a 5-stamp mill, recently extracted gold worth $100,000 in 4 days. The shoot, at 175 ft. depth, is 20 ft. long and from 15 to 20 in. wide. The mine is 15 miles from Huntington, in Baker county, near the Idaho border.

UTAH

In its 82-page annual number *The Salt Lake Tribune* devotes 14 pages to a review of mining in the State, covering outputs of the principal mines and districts, dividends, and share dealings.

BINGHAM. Owing to storms the Utah Copper Co. was forced to suspend operations at its mines and mills last week.

ALTA. The new railroad to this district is practically completed, only four miles from Tanner's Flat to Alta remaining to

be constructed. There is 12 ft. of snow in the town, but in places there is 40 ft. on the main highway. Snow-slides have been reported. Ore shipments are suspended.

COLTON. The Shearer interests of New York will complete their bond on the claims of the Utah Ozokerite Co. in Carbon county.

WASHINGTON

CHEWELAH. Instead of sinking a two-compartment shaft 500 ft. below the 1000-ft. level the United Copper company will sink three compartments. The plant will have a capacity of 2000 ft. The new mill of 150-ton capacity is ready for treatment. December profits were $24,000.

NORTHPORT. Since the smelter resumed work here there has been a great expansion in mining, and 1000 claims have been the scene of assessment work and development. The town has a population of 2000, a 300% increase. Three furnaces at the smelter employ 400 men. There are several good lead-silver mines in the district.

CANADA

BRITISH COLUMBIA

HEDLEY. On December 30 the Hedley Gold Mining Co. pays a dividend of 3% for the quarter, plus 2% extra.

ILLECILLEWAET. The new 150-ton mill of the Lanark Mining Co. is more than half completed, and will probably be ready for service not later than February 1. The company is controlled by Spokane interests. Large quantities of ore are ready for treatment, but because the mountain is too steep to permit of storing much ore, there has not been much work done in the mine pending erection of the mill.

YUKON

DAWSON. On December 1, with the temperature 20° below zero, the Canadian Klondyke company's four dredges were still at work. Three boats on the Klondike river may work for some time yet, as the ground is not frozen; but the boat on Hunker creek is digging gravel that has to be thawed by steam, and may cease during December. During the winter, repairs will be made in the shops, the dam and power-plant will be added to, and wood will be hauled.

To extend and strengthen the field of its graduate work in engineering, the University of Illinois at Urbana maintains 14 Engineering Experiment Station research fellowships. One other such fellowship has been established under the patronage of the Illinois Gas Association. These fellowships, for each of which there is an annual stipend of $500, are open to graduates of approved American and foreign universities and technical schools. Appointments to these fellowships are made and must be accepted for two consecutive collegiate years, at the expiration of which period, if all requirements have been met, the degree of master of science will be conferred. Not more than half of the time of the research fellows is required in connection with the work of the department to which they are assigned, the remainder being available for graduate study.

The 1917 Northwest Mining Convention will be held at Spokane, February 19 to 25. This is the most important mining event in the North-west, and is attended by mining men from the north-western States, British Columbia, and Alaska. Exhibits of ores, minerals, machinery, apparatus, and supplies are made, and there are four days of sessions devoted to the mining industry. The engineering societies hold technical sessions, there are stereopticon lectures for evenings, and the entertainment of visitors by a special committee. F. C. Bailey is secretary of the Northwest Mining Association at Spokane.

The Massachusetts Institute of Technology (Boston Tech) has issued its catalogue for December. In the 530 pages are detailed every phase of the institution's activities.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

J. M. CALLOW is here.

W. H. ALDRIDGE is in Nevada.

FORBES RICKARD is in Arizona.

WILLIAM FORSTNER has gone to Yuma county, Arizona.

CHARLES BUTTERS has returned to Oakland from London.

JOHN W. MERCER has returned to New York from Ecuador.

C. A. HEBERLEIN, lately at Baker City, Oregon, has gone to Los Angeles.

ALBERT L. WATERS has gone to the Hayden and Globe districts, Arizona.

J. K. TURNER has been examining the Arizona Ray property at Ray, Arizona.

D. R. THOMAS has been appointed manager of the Davidson mine at Porcupine, Ontario.

A. E. RAU-ROESLER is operating the White Oak at Bagby in Mariposa county, California.

C. D. KAEDING, manager of the Dome mine, Porcupine, has been on a visit to San Francisco.

J. H. ROSE has been appointed metallurgist for the Mason Valley company at Thompson, Nevada.

HOWLAND BANCROFT has closed his office at Oruro, Peru, and is now at New York, whence he will return to Denver early in February.

FRANCIS CHURCH LINCOLN, director of the Mackay School of Mines, Nevada, is examining mines in Ontario, Canada, returning to Reno on January 8.

H. H. NICHOLSON, consulting engineer for the Plinco Copper M. & M. Co. of Plumas county, passed through San Francisco recently on his way to Lincoln, Nebraska.

F. K. BRUNTON has resigned from the staff from the A. S. & R. Co. at Garfield, Utah, to become assistant superintendent for the Consolidated Arizona company at Humboldt, Arizona.

L. D. RICKETTS, president of the American Institute of Mining Engineers, will be present at the forthcoming meeting of the local section of the Institute, on January 9, and will deliver an address.

The U. S. Civil Service Commission announces an open competitive examination by January 16, 1917, for supervising mining engineer and metallurgist. From the register of eligibles resulting from this examination certification will be made to fill a vacancy in this position in the Bureau of Mines, Department of the Interior, for service in the field, at a salary of $4000 a year, and vacancies as they may occur in positions requiring similar qualifications, unless it is found to be in the interest of the service to fill any vacancy by reinstatement, transfer, or promotion. The duties of this position will be to take charge of one of the mining experiment stations. Competitors will not be required to report for examination at any place, but will be rated on the following subjects, which will have the relative weights indicated: (1) education, 30; (2) professional experience, 50; and (3) publications, reports, or thesis, 20; total, 100.

The U. S. Civil Service Commission announces an open competitive examination for assistant examiner in the Patent Office, on January 17, 18, and 19. From the register of eligibles resulting from this examination certification will be made to fill vacancies as they may occur in this position at the entrance salary of $1500 per year, in the United States Patent Office, Washington, D. C. As the supply of eligibles for this position has not been equal to the demand, qualified persons are urged to enter this examination. Subjects are physics, mathematics, technics, chemistry, French or German, and mechanical drawing.

THE METAL MARKET

METAL PRICES

San Francisco, January 2.

Antimony, cents per pound	12
Electrolytic copper, cents per pound	35
Pig lead, cents per pound	7.75—8.75
Platinum, soft and hard metal, per ounce	$85—91
Quicksilver, per flask of 75 lb	$80
Spelter, cents per pound	12
Tin, cents per pound	43
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, January 2.

Antimony, 50% metal, per unit	$1.00
Chrome, 40% and over, f.o.b. cars California, per ton.	15.00
Magnesite, crude, per ton	6.50— 9.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO_3, per unit	18.00—20.00

There is no change in the tungsten market. Antimony remains unchanged but with an outlook for somewhat lower price.

EASTERN METAL MARKET

(By wire from New York.)

January 2.—Copper is easy; consumers are offering; lead is dull and drifting; spelter is quiet, sellers outnumber buyers.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Dec. 27	75.37	Nov. 21	71.79
" 28	75.37	" 28	73.43
" 29	75.37	Dec. 5	75.05
" 30	75.37	" 12	75.37
" 31 Sunday		" 19	76.35
Jan. 1 Holiday		" 26	76.05
" 2	75.37	Jan. 2	75.37

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90	47.52	63.06
Feb.	57.53	48.45	56.74	Aug.	54.35	47.11	66.07
Mch.	58.01	50.61	57.89	Sept.	53.75	48:77	68.51
Apr.	58.52	50.25	64.37	Oct.	51.12	49.40	67.86
May	58.21	49.87	74.27	Nov.	49.12	51.88	71.60
June	56.43	49.03	65.04	Dec.	49.27	55.34	75.70

Throughout the week the silver quotations have remained unchanged, indicating a market without feature. A drop of 218 lakhs in the Indian treasury and the near approach of the Chinese new year are largely responsible for the steady and uneventful market.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Dec. 27	7.50	Nov. 21	7.02
" 28	7.45	" 28	7.21
" 29	7.50	Dec. 5	7.32
" 30	7.50	" 12	7.73
" 31 Sunday		" 19	7.69
Jan. 1 Holiday		" 26	7.50
" 2	7.50	Jan. 2	7.49

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80	5.59	6.40
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67	6.28
Mch.	3.94	4.04	7.26	Sept.	3.82	4.62	6.86
Apr.	3.86	4.21	7.70	Oct.	3.60	4.62	7.02
May	3.90	4.24	7.38	Nov.	3.68	5.15	7.07
June	3.90	5.75	6.88	Dec.	3.80	5.34	7.55

On Thursday, January 4, 1917, the Bunker Hill & Sullivan Mining Co. will pay dividend No. 242 of $81,750. On the same day the company will pay an extra dividend, No. 243, of $81,750. This brings the total dividends paid to date to $18,653,250.

The lead content of ore mined in 1916 is estimated at 622,000 short tons. Missouri was the largest producer, gaining 25% over the previous year. Gains were also made by California, Idaho, Nevada, Utah, and New Mexico. The average price for lead during 1916 was 50% higher than in 1915.

The United States Smelting, Refining & Mining Co. has declared a quarterly dividend of $1.25 a share on common stock and a regular quarterly dividend of 87½c. on preferred stock, both payable January 15.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Dec. 27	30.50	Nov. 21	32.87
" 28	30.00	" 28	34.00
" 29	30.00	Dec. 5	34.10
" 30	29.50	" 12	34.87
" 31 Sunday		" 19	34.04
Jan. 1 Holiday		" 26	31.55
" 2	29.50	Jan. 2	29.90

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	14.21	13.60	24.30	July	13.26	19.09	25.66
Feb.	14.46	14.38	26.62	Aug.	12.34	17.27	27.03
Mch.	14.11	14.80	26.65	Sept.	12.02	17.69	28.28
Apr.	14.19	16.64	28.02	Oct.	11.10	17.90	28.50
May	13.97	18.71	29.02	Nov.	11.75	18.88	31.95
June	13.60	19.75	27.47	Dec.	12.75	20.67	32.89

The Anaconda Copper Co. will pay the usual quarterly dividend of $2 per share, February 26.

East Butte has declared its initial dividend of $1 per share, payable January 29.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Dec. 27	9.75	Nov. 21	11.96
" 28	9.75	" 28	12.87
" 29	9.75	Dec. 5	13.20
" 30	9.75	" 12	12.25
" 31 Sunday		" 19	11.13
Jan. 1 Holiday		" 26	10.00
" 2	9.75	Jan. 2	9.75

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75	20.54	9.90
Feb.	5.22	9.05	19.99	Aug.	4.75	14.17	9.03
Mch.	5.12	8.40	18.40	Sept.	5.16	14.14	9.18
Apr.	4.98	9.78	18.62	Oct.	4.75	14.05	9.92
May	4.91	17.03	16.01	Nov.	5.01	17.20	11.81
June	4.84	22.20	12.85	Dec.	5.40	16.75	11.26

The zinc production for 1916 in the United States reached 708,000 tons, a gain of 20% over the production of 1915. The market has remained steady at 9.75c. throughout the week.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Date.		Dec. 19	80.00
Dec. 5	80.00	" 26	80.00
" 12	80.00	Jan. 2	80.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	39.25	51.90	222.00	July	37.50	95.00	81.20
Feb.	39.00	60.00	295.00	Aug.	80.00	93.75	74.50
Mch.	39.00	78.00	219.00	Sept.	76.25	91.00	75.00
Apr.	38.90	77.50	141.60	Oct.	53.00	92.90	78.20
May	39.00	75.00	90.00	Nov.	55.00	101.50	79.50
June	38.60	90.00	74.70	Dec.	53.10	123.00	80.00

The quicksilver market remained steady and unchanged throughout December at $80, with no indication of an early change.

The output of quicksilver for 1916 was 28,942 flasks valued at $3,643,800. It was the largest output since 1904, and the highest in value since 1875.

The New Idria company paid a dividend of $1 per share December 30.

TIN

Prices in New York, in cents per pound.

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60	37.38	38.37
Feb.	39.76	37.23	42.60	Aug.	50.20	34.37	38.88
Mch.	38.10	48.76	50.50	Sept.	33.10	33.12	36.66
Apr.	36 10	48.25	51.49	Oct.	30.40	33.00	41.10
May	33.29	39.28	49.10	Nov.	33.51	39.50	44.12
June	30.72	40.26	42.07	Dec.	33.60	38.71	42.55

Tin is strong at 42 cents.

Eastern Metal Market

New York, December 27, 1916.

The holiday quiet has been accentuated by the closing of the New York and London metal exchanges over Christmas, including what is known as 'Boxing Day' in London, or the day following Christmas day. This means that no cables were transmitted. Generally the trade is awaiting developments.

Second hands have been making the market in copper, and they have done business down to 31c. for prompt electrolytic. While dull, the market seems to be becoming firmer. The recent break was in part due to weak-kneed consumers who sought to sell because they feared a big drop in prices, and by speculative offerings, the latter, in some cases, applying to future deliveries of metal which the would-be sellers do not hold. In other words, short selling.

Zinc became very soft last week, and rather good buying resulted, but since then the market has stiffened. Dealers were the principal sellers.

Lead is almost without feature, except that the leading interest is willing to sell for February delivery, settlement to be on the basis of its average quotation for that month.

The tin trade is disturbed over Great Britain's decision to conceal, so far as possible, the arrival and departure of ships in her ports.

Antimony is dull. Aluminum is easier.

Recent events have combined to make the steel market a trifle quieter, though not nearly so quiet as is usual around the holidays. Specifications against contracts are as strong as ever. Deliveries are everywhere being halted or delayed by the freight situation. Given signs of a congestion, and a railroad immediately declares an embargo; and shippers are at sea. Lack of coke has caused the banking of many blast-furnaces, 19 of these belonging to the Steel Corporation. Less interest is being shown in extended deliveries, either of steel products or pig iron. Prices hold firm.

COPPER

Re-sale electrolytic has been offered down to 31c. for spot, 30c. for first quarter, and 29c. to 29.50c. for second quarter. Business was done at these figures late last week, but this week the market has been quieter. The metal in second hands is not so plentiful, and the holders have more faith in the future of prices. Some of the selling has been done on behalf of timorous consumers and some by speculators, a few of the latter seeking to sell short on futures, a phase of the situation which producers in particular, do not like. Lake is at the same level as electrolytic in a general way, although some high-grade Lake is held at higher figures. Around the prices mentioned the market is steadier. It is felt that the producers must adhere to their pegged prices in view of their sold-up conditions, also because any concessions offered by them at this time would have a tendency to demoralize the market. The New York and London metal exchanges have been closed since last Friday, and the absence of cabled information has accentuated the holiday aspect of the past few days. The London quotation for spot electrolytic this morning (December 27) was £152 against £161 eight days ago. Finished brass and copper prices are as strong as ever; hot-rolled sheet-copper being held at 42c. and cold-rolled at 43c., delivery at the convenience of the mills.

ZINC

Just before the Christmas holiday forward zinc was fairly active at lower prices. January to June was sold at 9c. to 9.12½c. St. Louis, and first quarter at 9.25c. St. Louis. Prompt continued reasonably firm, and yesterday (December 26) all positions showed less tendency to sag. At the low prices mentioned dealers were the principal sellers, but since the market has taken on a better tone the producers have evinced a willingness to sell also. The New York quotation for prompt yesterday was 9.75c., and that at St. Louis 9.50c. First quarter has sold this week at 9.37½c. to 9.50c., St. Louis. Operations in the West, including the making of shipments, are greatly hampered by transportation troubles. These are not only those imposed by the weather, but by the shortage of cars. Of the latter, there is country-wide complaint. There were no cables from London yesterday because of the 'Boxing Day' holiday, while the New York Metal Exchange was closed also; consequently no export figures are available at this writing. Sheet-zinc is unchanged at 21c. per lb. carload lots, f.o.b. mills, 8% off for cash. The quotation for spot-zinc at London today (December 27) was £51 10s.

LEAD

The general quotations for nearby delivery are 7.50c., New York, and 7.30c. to 7.40c., St. Louis. For prompt metal shipped out of warehouse in New York premiums are paid because of the paucity of such stocks. The A. S. & R. Co. is selling only for February delivery, for which settlement is to be on the basis of the average of its February quotations. Future lead is neglected and the prices easy. The London quotation for spot lead is unchanged at £30 10s.

TIN

The most important development in this metal that has come about in a long time is expected to result from the action of Great Britain, announced this week, in placing a ban upon shipping news. This means that ships will arrive at and sail from British ports without the fact being known. British vessels will sail for American ports, but sailings will not be reported and will not be known until the vessels arrive in American waters. Likewise, the time of arrival at ports on the other side will be kept secret. The object, of course, is to protect shipping from the activities of German raiders. It will keep importers and dealers in the dark as to the metal they have *en route* from London, and also hide more or less metal on the way from the Far East. The trade is puzzled over how the plan will work out, but wonders why it was not put into effect before. Except on December 20, the past week has been very quiet, and prices have declined. On the day mentioned, 400 to 500 tons changed hands, mostly May and June deliveries from the Far East, for which 40.5c. was the average price paid. The spot quotation for Straits yesterday was 40.87½c.

ANTIMONY

The market is stagnant. The nominal quotation for Asiatic grades is 14 to 14.25c., duty paid.

ALUMINUM

Quotations are easier at 60c. to 63c. for No. 1 virgin aluminum, 98 to 99% pure.

ORES

Tungsten. Inquiry continues to come from both domestic and export buyers. For the home market a considerable quantity has been taken at $17.50 per unit, and several hundred tons are under option to export buyers at the same price. English buyers are particularly anxious to obtain ore.

Molybdenite. The market is firm, with offerings limited. Quotations are unchanged at $1.80 to $2 per lb. MoS_2 contained.

Antimony. The quotation is unchanged at about $1.70 per unit in a dull market.

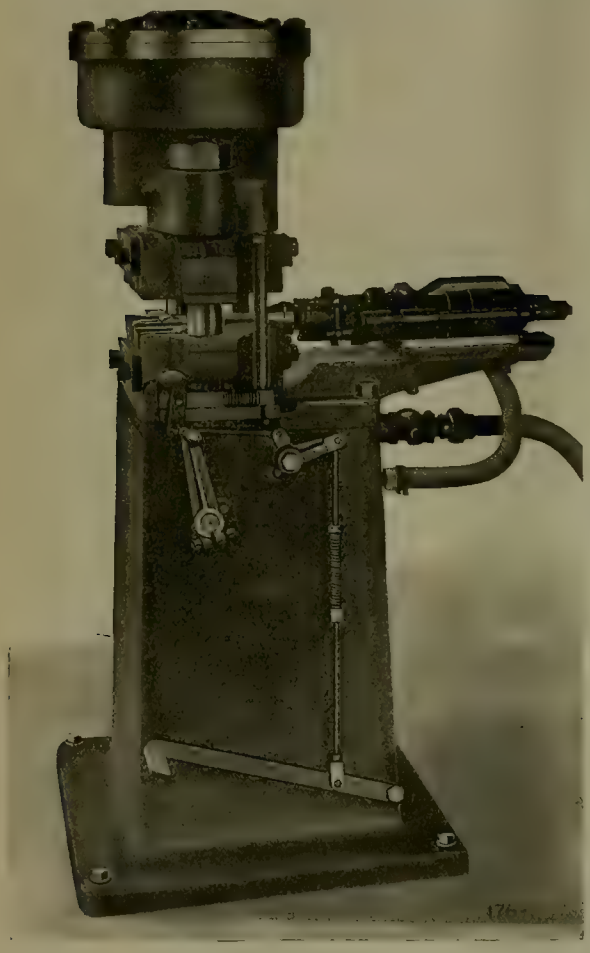
COAL OUTPUT of Canada during 1916 is estimated at 14,365,000 tons, an increase of 8%. Alberta, British Columbia, and Nova Scotia are the principal producing provinces.

Industrial Notes

Information supplied by the manufacturers.

New Type of Drill-Sharpener

A new design of pneumatic drill-sharpener has recently been developed by the Denver Rock Drill Manufacturing Co., and is now on the market. It consists of a pneumatic dolly-hammer and swaging-ram mounted on a single pedestal. This



THE NEW DRILL-SHARPENER.

ram not only operates the swaging-dies, but it also clamps the steel and operates the steel cutter. The ram-piston cylinder is fixed directly above the die-blocks, which the manufacturers claim not only gives it a powerful clamping effect, but is also responsible for the effectiveness of this machine under low air-pressures. The ram-piston is returned to its upward position by two small constant-pressure pistons, and when a blow is struck with the ram, or is brought down for the purpose of clamping the steel, the air in these constant pressure-cylinders is merely forced back into the pipe-line. The dolly-hammer is of the valveless type, and uses the air expansively, which contributes to the usual economy of air consumption that characterizes this machine. No springs are used in connection with the dollies, as they are returned by a small constant-pressure piston. This feature facilitates the changing of dollies, as there is no spring-pressure to overcome, and it also eliminates all trouble from spring breakage. All the operations of the machine are controlled by a single lever, which is so situated that the operator can readily observe the workings of the steel. There is but a single air-connection to the machine, which consists of a flexible hose. No exhaust-pipe is required, as the air is exhausted into the hollow base of the pedestal, and this is so muffled as to be hardly noticeable. The manufacturers have also developed a smaller drill-sharpener which they expect to put on the market in the near future.

Commercial Paragraphs

THE GENERAL ENGINEERING CO. of Salt Lake City is to prepare plans for another 500-ton unit at the Consolidated Coppermines property at Ely, Nevada.

STEPHENSON & NICHOLS of San Francisco have been appointed representatives for the Terry Steam Turbine Co. of Hartford, Connecticut, in northern and central California.

In Bulletin 263 the CHICAGO PNEUMATIC TOOL CO. describes the Boyer railway speed recorder. This can be fixed to any mine ground tramway. Bulletin 34-W covers Giant fuel-oil engines, their parts and applications.

In Bulletin No. 48,703 the GENERAL ELECTRIC CO. discusses its 'fabroil gears,' which are used in all types of machinery. This material, which consists of a cotton filler compressed under hydraulic pressure, has been in successful use for five years.

THE NATIONAL TUBE CO. of Pittsburg has been showing moving pictures illustrating the manufacture of its pipe from ore to finished product, before the Case School of Applied Science at Cleveland, and the National Association of Stationary Engineers at Coplay, Pennsylvania. We remember seeing similar films at the Panama-Pacific Exposition in 1915.

Recent Publications

BOLETIN DE MINAS. Por Pablo Ortega, ingeniero de minas. No. 1 Julio de 1916. P. 158. Ill., map, index. Habana, Republica de Cuba.

PROCEEDINGS of Mine Inspectors' Institute of the United States, held at Joplin, Missouri, in June 1916. P. 115. Illustrated. Pittsburg, Pa., 1916.

NOTES ON ALUNITE, PSILOMELANITE, AND TITANITE. By E. T. Wherry. P. 8. Reprint from Proceedings of the U. S. National Museum, Washington, D. C., 1916.

BOLETIN del Ministerio de Fomento, Republica Peruana. Segundo trimestre de 1916. Tomo 1 and 2. P. 729. Ill., index. 'La Opinion Nacional,' Calle del Correo, No. 194, Lima, Peru, 1916.

COALS OF CANADA. By J. B. Porter and others. P. 194. Charts, index. Department of Mines, Ottawa, Canada, 1916.

An investigation into the economic qualities conducted at the McGill University, Montreal.

MINING OPERATIONS IN QUEBEC DURING 1915. By A. O. Dufresne. P. 146. Ill., map, index. Department of Mines. Quebec, 1916.

The total mineral output was valued at $11,465,873, asbestos leading with $3,544,362.

State Geological Survey of Illinois, Urbana, 1916:

COAL RESOURCES OF DISTRICT VI. By G. H. Cady and others. Bulletin 15. P. 94. Ill., charts, index.

CHEMICAL STUDY OF ILLINOIS COALS. By S. W. Parr. Bulletin 3. P. 86. Charts, index.

PRELIMINARY OIL REPORT ON SOUTHERN ILLINOIS. By A. D. Brokaw. Extract from Bulletin 35. P. 13. Maps.

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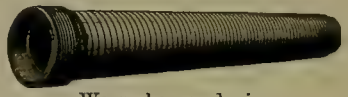

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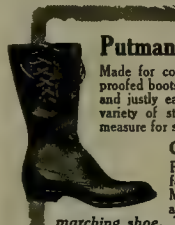

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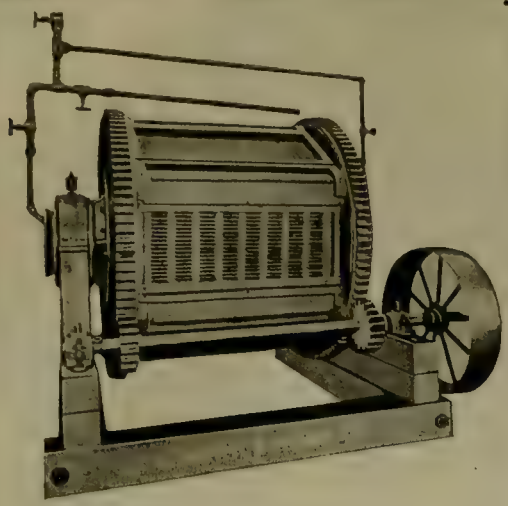

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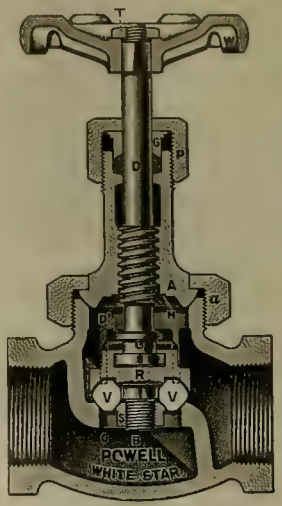

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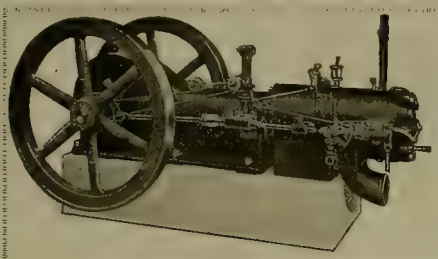

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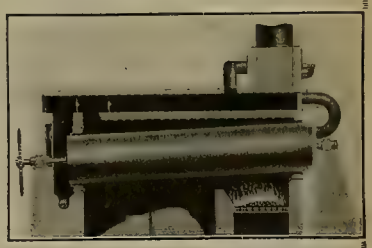

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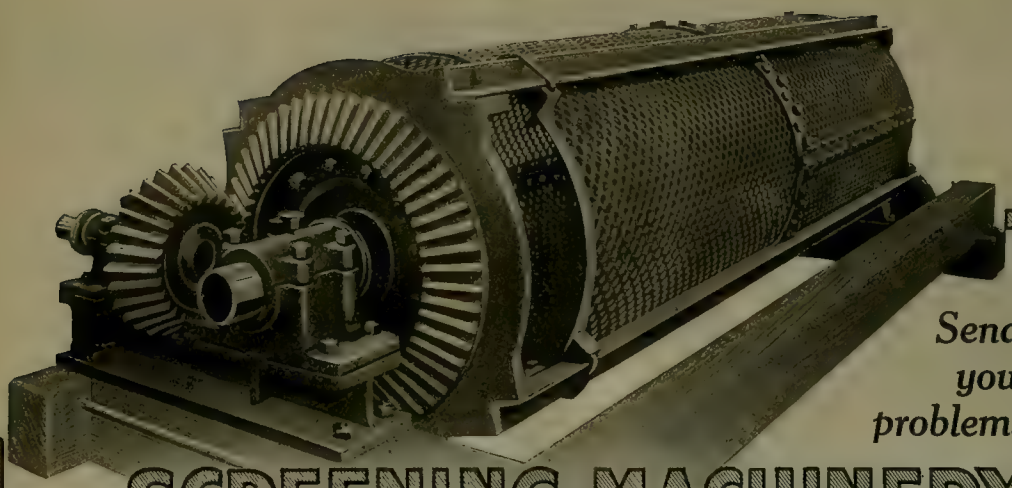

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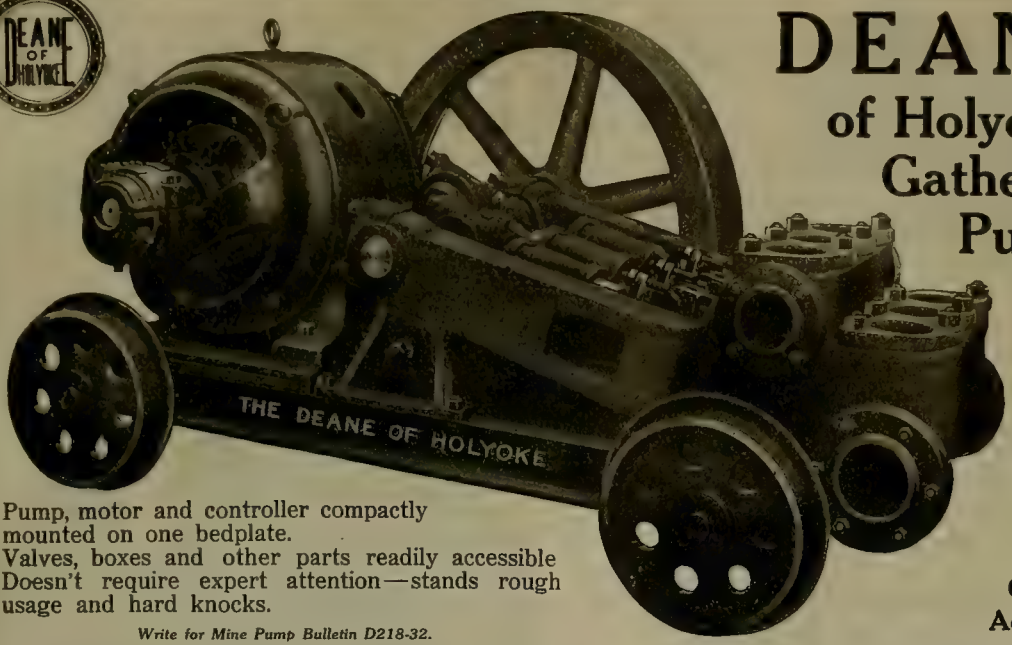

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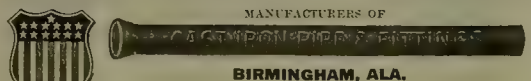

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COLORADO

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Wilkens and Devereux.

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McCann, Ferdinand.
Strauss, Lester W.

PROFESSIONAL DIRECTORY

ABBOTT, James W.,
Mining Engineer.
123 N. Grand Ave., Los Angeles, Cal.

ALDERSON, Victor C.,
Consulting Mining Engineer.
1043 Emerson St., Denver, Colo.

ALDRIDGE, Walter H.,
Mining and Metallurgical Engineer.
% Wm. B. Thompson,
14 Wall St., New York.

ALEXANDER, HILL & STEWART,
Consulting Engineers and Metallurgists.
4 Broad St. Place, London, E.C.

ARGALL & SONS, Philip,
Mining and Metallurgical Engineers.
First National Bank Bdg., Denver.
Cable: Argall. Code: Bedford McNeill.

ARNOLD, Ralph, Cable: Ralfarnoll.
Geologist and Petroleum Engineer.
Union Oil Bdg., Los Angeles, Cal.
120 Broadway, New York.
No. 1, London Wall Bdg., London, E.C.

BALL, Sydney H.,
Mining Geologist.
71 Broadway, New York.
Cable: Sydball. Code: Bedford McNeill.

BANCROFT, Geo. J.,
Consulting Engineer.
Mining, Metallurgy, Hydraulics.
Bancroft Blk., 220 Broadway, Denver.
Cable Address: Bancroft.

BANCROFT, Howland,
Consulting Mining Geologist.
Symes Bdg., Denver, Colo.
Casilla No. 215, Oruro, Bolivia.
Cable: Howban. Code: Bedford McNeill.

BANKS, John H.,
(Formerly of Ricketts & Banks)
Mining Engineer and Metallurgist.
61 Broadway, New York.

BARD, D. C.,
Mining Geologist.
660 Stuart Building,
Seattle, Wash.

BARKER, Edgar E.,
Mining Engineer.
Chuquicamata, Chile.

BAYLDON, H. C.,
Mining Engineer.
Fort, No. 2, Sirdarensky Oblast,
Russia.

BEATTY, A. Chester,
Consulting Mining Engineer.
25 Broad Street, New York.
1, London Wall Bdg., London, E.C.
Cable: Granitic. No professional work.

Hamilton, Beauchamp, Woodworth, Inc.
BEAUCHAMP, F. A.,
Metallurgist.
Specialty: Flotation.
419 Embarcadero, San Francisco.

BELLINGER, H. C.,
Metallurgical Engineer.
% Chile Exploration Co., Chuquicamata
(via Antofagasta) Chile, South America.

BENEDICT, William de L.,
Mining Engineer.
19 Cedar St., New York.

BOTSFORD, Robert S.,
Mining Engineer.
% F. Riches, 9th Line, No. 44,
Basil Island, Petrograd, Russia.

BRADLEY, D. H. Jr.,
Mechanical Engineer.
Mill design. Mine equipment. Mine management.
Bank of Arizona Bdg., Prescott. Ariz.

Corey C. Brayton. E. R. Richards.
BRAYTON & RICHARDS,
Mining and Metallurgical Engineers.
Hobart Bdg., San Francisco.

BRETHERTON, S. E.,
Con. Mining and Met. Engineer.
Specialty: Smelting of copper and lead ores and treatm't of complex zinc ores.
220 Mills Bdg., San Francisco.

BREWER, Wm. M.,
Mining Engineer and Geologist.
P. O. Box 701, Victoria, B. C.
Cable: Brewer. Code: Bedford McNeill.

BRINSMADE, Robert Bruce,
Consulting Engineer.
No. 9a Galena No. 1, Puebla, Pue.,
Mexico.

BROADBRIDGE, Walter,
Chief Engineer,
Minerals Sep., Ltd., 62 London Wall, E.C.
Cable: Rillstope, London.
(Temporarily on Active Service.)

BRODIE, Walter M.,
Mining Engineer and Metallurgist.
50 Broad St., New York.

BROWN, Frederick C.,
Mining Engineer.
R.F.D. 4, Boise, Idaho.

BROWN, R. Gilman,
Consulting Engineer.
62, London Wall, London, E.C.
Cable: Argeby. Usual Codes.

BULKLEY, J. Norman,
Consulting Mechanical and Electrical Engineer.
Mining Work a Specialty.
120 Broadway, New York.

Burch, Caetani & Hershey.
BURCH, Albert,
Consulting Engineer.
Crocker Bdg., San Francisco.
Cable: Burch. Usual Codes.

BURCH, H. Kenyon,
Mechanical and Metallurgical Engineer.
% The Sierra Madre Club,
Los Angeles, California.

BURGER, C. C.,
Mining Engineer.
71 Broadway, New York.

Burch, Caetani & Hershey.
CAETANI, Gelasio,
Consulting Engineer.
Crocker Bdg., San Francisco.
Cable: Caetani. Usual Codes.

CARPENTER, Alvin B.,
Mining Engineer.
508 Union League Building,
Los Angeles.

CHANCE & CO., H. M.,
COAL Mining Engineers. IRON
839 Drexel Bdg., Philadelphia.

CHANNING, J. Parke,
Consulting Engineer.
61 Broadway, New York.

CHASE, Charles A.,
Mining Engineer.
812-824 Cooper Bdg., Denver.
Liberty Bell G. M. Co., Telluride, Colo.

M. F. Chase. W. D. Main.
CHASE & MAIN,
Metallurgical Engineers.
1610 First National Bank Bdg.,
Chicago, Ill.

Edwin E. Chase. R. L. Chase.
CHASE & SON, Edwin E.,
Mining Engineers.
1028 First Nat'l Bank Bdg.,
Denver, Colo.

CHODZKO, A. E.,
Consulting Mechanical Engineer.
Specialty: Compressed Air.
647 Phelan Bdg., San Francisco.

CLARK, Baylies C.,
Mining and Mechanical Engineer.
Sutter Creek, California.
Cable: Baclark. Code: Bedford McNeill.

CLEVENGER, G. Howell,
Metallurgical Engineer.
381 Hawthorne Ave., Palo Alto, Cal.

COLE, F. L.,
Mining Engineer.
Shanghai, China.
Cable: Hanco.

PROFESSIONAL DIRECTORY

COLLBRAN, Arthur H.,
Mining Engineer.
General Manager Seoul Mining Co.
Pyeng Yang, Korea.

COLLINS, Edgar A.,
Mining Engineer.
Care 1013 Crocker Bdg., San Francisco.

COLLINS, Edwin James,
Mining Engineer.
Mine Examinations and Management.
1008-1009 Torrey Bdg., Duluth, Minn.

COLLINS, George E.,
Mining Engineer.
Mine Examinations and Management.
414 Boston Bdg., Denver.
Cable: Colcomac.

COLLINS, Henry F.,
Mining and Metallurgical Engineer.
66 Finsbury Pavement,
London, E.C.

COPELAND, Durward,
Metallurgical Engineer.
Missouri School of Mines, Rolla, Mo. Llallagua, Bolivia.

COULDREY, Paul S.,
Mining Engineer.
Gen. Mining Supt. Cerro de Pasco Mining Co., Cerro de Pasco, Peru, S. A.
Cable: Cerrocop.

CRANSTON, Robert E.,
Mining Engineer.
437 Holbrook Bdg., San Francisco.
60 Wall St., New York.
Cable: Recrans. Code: McNeill, 1908.

CREDEN, William L.,
Consulting Mining Engineer.
Mine Examination and Management,
First National Bank Building,
Butte, Montana.

CURLE, J. H.,
Mine Valuer.
62, London Wall, London.

DE KALB, Courtenay,
Consulting Engineer, Pacific Smelting & Mining Co., Tucson, Arizona.
Cable: Dekalb. Code: McNeill.

de MARNEY, E. N. Barbot,
Mining Engineer.
W. O. Stredny Prospect, 33
Petrograd, Russia.
Cable: Barbot de Marney. Code: McN.,'08

DENNIS, Clifford G.,
Mining Engineer.
Crocker Bdg., San Francisco.
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DICKERMAN, Nelson,
Mining Engineer.
The Insurance Exchange,
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Consulting Mining Engineer.
Specialty Non-metallic minerals.
1010 Flatiron Bdg., San Francisco.

DORR COMPANY, THE,
John V. N. Dorr, President.
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Denver. New York. London, E.C.

DRUCKER, A. E.,
Mechanical and Metallurgical Engineer.
Ore Dressing, Cyaniding, Copper Leaching, Testing, Designing, Construction.
1502 Pacific St., Brooklyn, N. Y.

DUNSTER, Carl B.,
Mining Engineer.
11 Pine St., New York.
Marquette, Mich.
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DWIGHT, Arthur S.,
Mining Engineer and Metallurgist.
29 Broadway, New York.
Cable: Sinterer.
Code: McNeill; Miners & Smelters.

DYER, S. C.,
Mining Engineer.
P. O. Box 19, Bulawayo, Rhodesia.
Cable: Minerals. Usual Codes.

EASTON, Stanly A.,
Mining Engineer.
Manager Bunker Hill & Sullivan Mining & Concentrating Company.
Kellogg, Idaho.

EMERY, A. B.,
Mining Engineer.
Management and Equipment of Mines,
Messina, Northern Transvaal,
South Africa.

EYE, Clyde M.,
Mining and Metallurgical Engineer.
Supt. Benguet Consolidated Mining Co.,
Baguio, Benguet, P. I.

FARISH, John B.,
Mining Engineer.
58 Sutter St., San Francisco.
315 Colorado Bdg., Denver.
Cable: Farish.

FINCH, John Wellington,
Geologist and Mining Engineer.
46 Rue Massenet, Shanghia, China.
No examinations undertaken.

FINLAY, J. R.,
Mining Engineer.
Room 802, 52 William St.,
New York.

FISHER, C. A.,
Consulting Geologist & Fuel Engineer.
First Nat'l. Bank Bdg., Denver, Colo.
Kearns Bdg., Salt Lake City, Utah.
Cable: Cafishoil. Usual Codes.

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Mining Engineer and Metallurgist.
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Cable: Fowler. Usual Codes.

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Mining Geologist.
% Broken Hill Assoc. Smelters, Ltd.,
Collins House, Melbourne, Victoria,
Australia.

FREITAG, K.,
Mechanical and Metallurgical Engineer.
Mine and Metallurgical Plant Design and Construction.
1008 Hobart Bdg., San Francisco.

GARREY, George H.,
Consulting Mining Geologist and Engineer.
Bullitt Bdg., Philadelphia, Pa.

GARRISON, F. Lynwood,
Mining Engineer.
982 Drexel Bdg., Philadelphia.
Cable: Aurum. Code: McNeill.

GAY, Frederick W.,
Consulting Engineer.
Mechanical and Electrical Installations.
Purchasing—Inspection—Supervision.
310 Sansome Street, San Francisco.
Correspondent
The J. G. White Engineering Corp.,
New York City, New York.
Engineering, Construction, Financing.

GEMMILL, David B.,
Mining and Metallurgical Engineer.
General Manager Bradshaw Reduction Company,
Crown King, Arizona.

GEPPERT, R. M.,
Mining Engineer.
Salisbury House, London, E.C.
Code: McNeill.

GESTER, G. C.,
Geological and Mining Engineer.
919 First Nat. Bank Bdg.,
San Francisco, Cal.
Cable: Gester, San Francisco.

GIBSON, Arthur,
Mining Engineer.
Specialty: Placer Mining.
1022 Haight St., San Francisco.

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Mining Engineer.
Gen. Mgr. Waihi Grand Junction,
Waihi, N. Z.
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GRANT, Wilbur H.,
Geologic and Mining Engineer.
437 Holbrook Bdg., San Francisco.
Code: Bedford McNeill.

GREENE, Fred T.,
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Exam., Development and Management.
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419 The Embarcadero, San Francisco.

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Hobart Bdg., San Francisco.

HARDMAN, John E.,
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112 St. James St., Montreal, Canada.
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HENDERSON, H. P.,
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60 Broadway, New York.

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HERZIG, Charles S.,
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HEINZ, N. L.,
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Metallurgy of Zinc and Manufacture of Sulphuric Acid.
523 St. James Place, Pittsburgh, Pa.

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Mine Examinations and Reports.
Oatman, Arizona.

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Mines examined with a view to purchase.
Copper Cliff, Ontario.

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Mining Engineer.
2 Rector St., New York.
Code: McNeill, 1908.

HOFFMANN, Ross B.,
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228 Perry St., Oakland, Cal.
Cable: Siberhof.

HOLLIS, H. L.,
Consulting Mining Engineer and Metallurgist.
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% Commission of Relief in Belgium,
3 London Wall Bdgs., London, E.C.
Cable: Crevooh.

HOOVER, Theodore J.,
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1, London Wall Bdg., London, E.C.
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Cable: Mildaloo.

HOWARD, L. O.,
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Examination, Consulting, Management.
421 Felt Bdg., Salt Lake City, Utah.

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Apartado 8, El Oro, Mexico.

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St. Louis-Montreal-London.
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Chemical, Physical and Cement Laboratories.

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Mining Engineer.
634 Mills Bdg., San Francisco.
Cable: Haruston.

HUTCHINS, John Power,
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Apartment 24, Morskaya 21, Petrograd.
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Treatment of Difficult Ores.
634 Mills Bdg., San Francisco.
Cable: Jamehyde.

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Codes: McNeill, 1908, A.B.C., 5th ed.

Dudley J. Inskip. John A. Bevan.
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1, Broad St. Place, London, E.C.
Cable: Monazite. Usual Codes.

JANIN, Charles,
Mining Engineer.
722 Kohl Bdg., San Francisco.
Cable: Charjan. Code: McNeill.

JENKS, Arthur W.,
Mining Engineer and Metallurgist,
% Burma Mines, Ltd., Namtu, Northern Shan States, Burma, India.

JONES, T. J.,
Mining Engineer.
No. 1 Nevsky Prospect,
Petrograd, Russia.

JUESSEN, Edmund,
Mining Engineer.
2815 Parker St., Berkeley, Cal.

KEFFER & JOHNS,
Mining Engineers.
Examinations, Reports and Management of Mining Properties.
610 Hutton Bdg., Spokane, Wash.

KINNON, Wm. H.,
Mining Engineer and Metallurgist.
307 San Francisco St.,
El Paso, Texas.

KINZIE, Robert A.,
Mining Engineer.
First National Bank Building,
San Francisco.

KIRBY, A. G., **Metallurgist.**
Mill Designing and Construction.
Specialty: Concentration & Cyanidation.
121 Howard Park Ave., Toronto, Ont., Canada.

KIRBY, Edmund B.,
Mining Engineer and Metallurgist.
918 Security Bdg., St. Louis.
Specialty: The expert examination of mines and metallurgical enterprises.

KIRK, Charles T.,
Mining Geologist.
Albuquerque, New Mexico.

KIRK & LEAVELL,
Consulting Engineers.
Examination, Management, and Operation of Mines. Design Equipment.
Newhouse Bdg., Salt Lake City, Utah.

KRUMB, Henry,
Mining Engineer.
Felt Bdg., Salt Lake City, Utah.

KUEHN, A. F.,
Consulting Mining Engineer.
1 London Wall Building,
London, E.C.
Cable: Norite.

LAKENAN, C. B.,
Mining Engineer.
Ely, Nevada.

LAMB, Mark R., M.E.,
Santiago, Chile.
Mgr. for Allis-Chalmers in S. A.
Data and information available on mines and equipment.

LAMB, R. B.,
Mining Engineer.
Room 75, 25 Broad St.,
New York City.
Cable: Boblam. Code: McNeill.

PROFESSIONAL DIRECTORY

LANAGAN, W. H.,
Mining Engineer.
1057 Monadnock Bdg.,
San Francisco. Code: McNeill.

LANDERS, William H.,
Specialty: Quicksilver
New Almaden, California.

LEVENSALER, L. A.,
Mining Engineer.
Box 1454, Tacoma, Washington.

LEVY, Ernest,
Mining Engineer.
Representing Alex. Hill & Stewart,
Rossland, British Columbia.

LEWIS, H. Allman,
Managing Engineer.
The Porco Tin Mines, Ltd.
Casilla 52, Potosi, Bolivia.
Cable: Porcorama. Code: McNeill (1908)

LLOYD, R. L.,
Metallurgical Engineer.
Specialty: Pyro-Metallurgy of Copper and Associated Metals. Cable: Ricloy.
Code: McNeill. 29 Broadway, N. Y.

LONGYEAR COMPANY, E. J.,
Exploring Engineers and Geologists.
Diamond Drill Contractors.
Manufacturers of Diamond Drills and Supplies.
General Office: 710-722 Security Bank Bdg., Minneapolis, Minn.
Cable: Longco. Code: McNeill.

Bewick, Moreing & Co.
LORING, W. J., **Mining Engineer.**
62, London Wall, London, and
1018 Crocker Bdg., San Francisco, Cal.
Cable: Wantoness. Usual Codes.

LUNT, Horace F.,
Mining Engineer.
Gazette Bdg., Colorado Springs, Colo.

MACKAY, Angus R.,
Mining Engineer.
740 E. Adams St., Phoenix, Ariz. 35 Congress St., Boston, Mass.

MACNUTT, C. H.,
Mining Engineer.
% Institution of Mining and Metallurgy, London.

MASON, Russell T.,
Mining Engineer.
2142 W. 30th St., Los Angeles, Cal.

MASSEY CO., George B.,
Consulting Excavating Engineers.
Advice on Equipment and Methods for Stripping, Open-Cut Mining, Dredging.
Peoples Gas Bdg., Chicago, Illinois.

MATHER, Thomas William,
Mining Engineer.
Room 1027, 15 Broad St., New York.
Cable: Matherite.
Codes: Bed. McN., Miners & Smelters.

MAYREIS, L. J.,
Mining Engineer.
% Burma Mines, Ltd.,
Namtu, Burma.

McBRIDE, Wilbert G.,
Mining Engineer.
Assistant General Manager,
The Detroit Copper Mining Company,
Morenci, Arizona.

McCANN, Ferdinand,
Consulting Mining and Metallurgical Engineer.
La Cotabambas Auraria,
% A. Calvo, Cuzco, Peru, S. A.

McCARTHY, E. T.,
Mining Engineer.
10 Austin Friars, London.

McDERMOTT, E. D.,
Mining Engineer.
Zyrianovsk Roudnik.
Tomsk Government, Siberia.
Codes: McNeill, 1908; Moreing & Neal.

MEIN, William Wallace,
Mining Engineer.
43 Exchange Place, New York.
Cable: Mein, New York.

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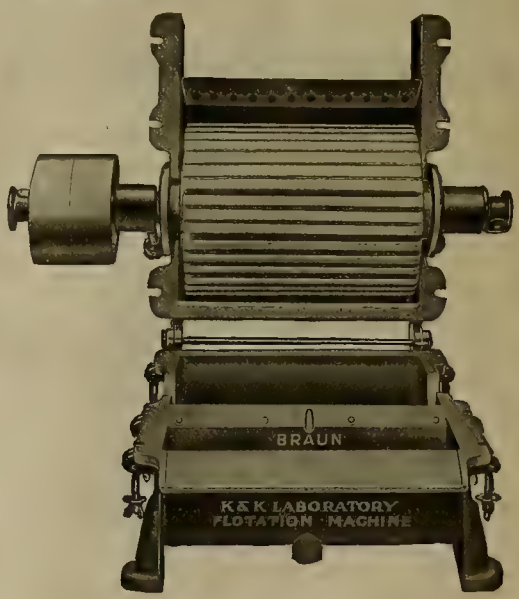

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Prompt Delivery

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The cost of an engineering instrument is measured by the duration of its accuracy. By this standard "BUFF" Instruments are far most economical.

Write for Catalog 31

Buff & Buff Company

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Not for the man equipped with—

PROTO (FLEUSS) (DAVIS) Self-Contained Oxygen Apparatus

This apparatus has been approved by the U. S. Bureau of Mines. It has been tested and proved by mine operators all over the world. It has replaced other apparatus time and time again. Why? Because of certain features explained on request. "PROTO" is reasonably priced, sturdy, lasting, simple. *Write for details.*

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A-9 OF BALANCES
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MADE IN CALIFORNIA

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is an acid-resisting alloy made in accordance with specially developed metallurgical experience and by the use of a special selection of metalloids suitable for resistance to corrosion of acid and alkaline solutions.

when used for standard fittings through which acid or alkaline solutions must pass, will return its cost in money saved within a short time after being put in use.

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Note—Something New in Air Pipe
ALL SIZES AND GAUGES

Made from a single sheet of Galvanized Iron 10 feet long.
Notice the long swedged Joint and Lugs.

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Turbine **PUMPS** Centrifugal
Where the service is hardest you will find the Jackson.
Write for Catalog No. 25-x
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Mining and Scientific Press THE OPPORTUNITY PAGE

OPPORTUNITIES

Under this heading announcements may be made of new and second-hand machinery or supplies, for sale or wanted. The cost is five cents per word, one dollar minimum order. Remittances MUST accompany order. Copy must be received by Saturday morning for the following week's issue.

WANTED—Chrome iron ores containing not less than 40 per cent chromic oxide nor more than 8 per cent silica. Deposits meeting these requirements will be investigated and shipmnts contracted for. Address American Refractories Company, S. H. Dolbear, engineer, Flatiron Building, San Francisco. TF

WANTED—Ores, metals, mattes and bullion for export, especially rare, complex and rebellious materials. L. C. Butler, 71 Wall St., New York City. LT-1-27-17

WANT HAULING CONTRACTS ANYWHERE. Work done with auto-trucks and caterpillar engines. Estimates furnished. California Auto Trucking Co., 860 Waller St., San Francisco. LT-12-30

FOR SALE—A good quicksilver claim in Lake county, California. Will give good terms. Address B. H. Otto, 1022 22nd street, Oakland, California. LT-12-2

WANTED TO PURCHASE 600 tons of chrome ore. Reply to Manganese Co. of California, 180 Sutter St., San Francisco, Cal. TF

CORPORATION CHARTERS, AGENTS, ETC.

NEVADA INCORPORATIONS SAVE COSTS; UNEQUALLED ADVANTAGES—Forms, information, etc., free. Dept. A2, INTERSTATE CORPORATION SERVICE SYSTEM, Reno, Nevada; Clarksburg, West Virginia. Incorporations anywhere. TF

FOR SALE—50-lamp lighting plant, never used; 7 H.P. upright engine; Westinghouse generator; switchboard; 1500 ft. rubber-covered wire; 50 Mazda lamps, 40 watts; weatherproof sockets, switches, etc. New, complete, ready to set up. Immediate delivery from El Paso. Geo. H. Briggs, 828 Central Bdg., Los Angeles, Cal. LT-1-6-17

WRITE HELENA MINING BUREAU, Inc., Helena, Mont., for booklet describing mining investment opportunities in the Helena Mining Region as outlined in Bulletin No. 527, United States Geological Survey.

NEW AND SECOND-HAND MACHINERY

Before you order your equipment get my prices on new and second-hand boilers, steam and gas engines, pumps and all classes of machinery. Also carry a line of high compression Diesel crude oil engines in small sizes. No spark troubles; just the engine for prospectors.

Give full details when writing

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In every issue of the MINING and Scientific PRESS will be found a quick means for disposing of used machinery. Insert a classified advertisement on the "Opportunity Page." Rates are five cents per word; 2½ cents per word when 500 words are contracted for. No advertisement accepted for less than $1. Every mine or mill manager wants used machinery at some time, perhaps, just when you have it to sell. Try—

THE OPPORTUNITY PAGE

SECOND-HAND MINING MACHINERY

Moore Type "A" Filter, capacity 300 tons in 24 hours. Complete vacuum pumps, extra filter basket, hydraulic crane for handling baskets, all tanks, etc. This is a bargain.

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1—Davis Portable 3-stamp, 500-lb. Prospector's Mill with timbers and plates.
1—McFarlane Portable 5-stamp Mill, 300-lb. Prospector's Mill with timbers.
1—Nissen 1350-lb. stamp Amalgamating Mortar, complete with feeder.
1—2 stamp Nissen Mill, 1350-lb. stamps.
1—Tremain Steam Stamp Mill with two stamps. Nearly new.
40—1050-lb. Stamps, Steel Cams and Tappets.
20—850-lb. Stamps. Nearly New.
30—350-lb. Stamps.
20—750-lb. Stamps.

Can furnish single or double discharge mortars for above stamp mills; any size furnished complete with new.

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1—M. S. 8-cell Flotation Machine.
1—M. S. 4-cell Cleaner Flotation Machine.

Several small machines for testing and laboratory work.

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1—18 and 28 and 42x10x35 Knowles triple expansion duplex.
1—18x34x9¾x36 Snow duplex compound condenser pump.
1—26 and 15x8x24 Knowles duplex compound pot valve.
1—24 and 14x7x24 Knowles duplex compound.
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3-phase, 60 cycle

1—250 Hp. Gen'l Electric, 440 volts
1—235 Hp. Gen'l Electric Synchronous, 440 volts.
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3—100 Hp. Gen'l Electric, 440 volts.
1— 75 Hp. Gen'l Electric, 2200 volts.
1— 50 Hp. Gen'l Electric, 440 volts.
4— 30 Hp. Gen'l Electric, 440 volts.
13—15 Hp. Gen'l Electric, 440 volts.
3— 10 Hp. Gen'l Electric, 440 volts.

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5—20-ft. Dorr Thickeners.
2—24-ft. Dorr Thickeners.
2—27-ft. Dorr Thickeners.
2—33-ft. Dorr Thickeners.
3—Rothwell Agitators.
5—8-ft. Callow Tanks.

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1—7x10 Blake Crusher.
1—7x11 Dodge Crusher.
3—9x15 Blake Crushers.
2—13x24 Blake Crushers.
1—9x16 Western Steel Crusher.
1—No. 2 Gardner Crusher.
1—No. 1-D Gates Crusher.
1—No. 3-D Gates Crusher.
1—Size "C" Comet Crusher.
2—No. 5 Austin Gyratory Crushers.

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1—Set 6x10 Sample Rolls.
1—Set 14x26 Stearns-Rogers Rolls.
3—Sets 16x36 McFarlane Rolls.
1—Set 12x20 McFarlane Rolls.
2—Sets 14x27 Davis Rolls.
8—Sets 16x36 Davis Rolls.
2—Sets 16x36 Colo. Iron Works.
1—Set 16x40 Colo. Iron Works.
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1—Set 5x18 Triplex Rolls.
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Good—for all purposes—any gage

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California, Nevada, Arizona.

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Mining and Scientific Press THE OPPORTUNITY PAGE

POSITIONS WANTED

The cost of advertising for positions wanted is 2 cents per word per insertion. Minimum order 50 cents. Replies forwarded without extra charge. Remittances must accompany order. Copy must be received Saturday morning for following week's issue.

YOUNG MINING ENGINEER open for engagement January 1. Five years experience, assayer, surveyor, draftsman, mining and milling. Will give any previous employer as reference as to character, industry, loyalty and accuracy. Married. Go any place where living conditions are reasonably good. Interview in San Francisco. Address Box 483, Mining and Scientific Press. LT-1-6-17

WANTED—A position with a mining company by a mining carpenter. Experienced, reliable, capable. Address Box 485, Mining and Scientific Press. LT-1-13-17

TECHNICAL GRADUATE, married, three years experience in cyanide plants, two years underground, wishes position with mining company, cyaniding preferred; can furnish references. Address Box 486, Mining and Scientific Press. LT-1-13-17

YOUNG MINING ENGINEER desires permanent position. Underground experience in California and Nevada. Smelting experience in Utah. Age 27, technical graduate. Address Box 487, Mining and Scientific Press.

MINING ENGINEER, 12 years experience United States and South America seeks engagement. Good executive; speak Spanish. Will go anywhere. Address Box 480, Mining and Scientific Press. LT-1-13-17

POSITION WANTED—Recent technical graduate desires position of any kind; good references. Address Box 476, Mining and Scientific Press. LT-1-13-17

SUPERINTENDENT who does not require corps of assistants for management of small property. Willing to work on bonus system if desired and will go anywhere. Address Box 474, Mining and Scientific Press. LT-1-16-17

ASSAYER AND SAMPLER open for position. Thoroughly competent, many years experience, steady, reliable, would make himself generally useful. Address Box 472, Mining and Scientific Press. LT-1-6-17

CHEMIST AND METALLURGIST desires position, 15 years cyaniding experience. Especially successful treating concentrates and handling difficult ore problems. Splendid references. Address Box 455, Mining and Scientific Press. LT-1-20-17

FOR SALE

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Contemporary with many of the most illustrious masters of Art, Literature and Navigation of the middle ages, Agricola was the conspicuous authority of his time on Mining and will ever be remembered for his great work on the subject. A classic which will endure—

De Re Metallica

Confident that there are still many who have not seen the First English translation, and who would like to know more of this valuable volume, for them we have issued a brochure of 32 pages, entitled "The Book That Made Agricola Famous." Sufficient of the illustrations are reproduced to give an excellent impression of how able and advanced the miners of the XVI century were. Sent free.

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MINING and Scientific PRESS

420 MARKET ST., SAN FRANCISCO 54

MINING AND SCIENTIFIC PRESS wants a permanent circulation representative in every mining community in the world. Replies will be held confidential if desired. Address, The Manager, Mining and Scientific Press.

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Announcements in this column are secured through the co-operation of many of the largest mining companies in the United States. Readers of Mining and Scientific Press are thus kept constantly informed concerning opportunities for employment.

TEMPORARY FREE REGISTRATION

While present heavy demand continues for well qualified men all branches mining, milling, smelting, we will accept, without registration charge, applications from mining men who are technical graduates. Desirable positions secured promptly. Established fourteen years. Business Men's Clearing House, Denver, Colorado. LT-2-17-17

WANTED—Technical, operating, clerical, and construction men for salaried positons in South America. Address Employment Department, Chile Exploration Co., Braden Copper Co., 120 Broadway, New York City. LT-1-13-17

MECHANICAL DRAFTSMEN

Several men experienced on mill and smelter design. Liberal salaries. Business Men's Clearing House, Denver, Colorado. LT-1-6-17

WANTED—Mechanical draftsman for San Francisco office. Must be familiar with machine and metallurgical mill design. State training, experience, age and salary expected. Address Box 484, Mining and Scientific Press. LT-1-6-17

WANTED—Draughtsman, familiar with design and construction of concentrating mills. Address Box 479, Mining and Scientific Press. LT-1-6-17

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Notary Public and Commissioner of Deeds for New York,
805 Pacific Bdg., Fourth and Market Streets, San Francisco.

THE · BUYER'S · GUIDE

Machinery and Supplies of Dependable Manufacturers are here Listed
Addresses will be found on the Sixth following Page ···
If you do not find what you want, communicate with MINING and SCIENTIFIC PRESS SERVICE

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Bullard, E. D.

Acetylene Lamps
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Bullard, E. D.
Harron, Rickard & McCone.
Justrite Mfg. Co.

Agitators
Chalmers & Williams.
Dorr Company, The.
Hammond Iron Works.
Harron, Rickard & McCone.
Meese & Gottfried Company.
National Tank & Pipe Co.
Pacific Tank & Pipe Co.
Traylor Eng. & Mfg. Co.
Western Pipe & Steel Co.

Air Brakes
Western Pipe & Steel Co.
Westinghouse Electric & Mfg. Co.

Air Pipe
Ames-Irvin Co.

Air Receivers
Western Gas Engine Corp.
Western Pipe & Steel Co.

Air Valves
Powell, Wm., Co., The.

Amalgamated Plates
Hendy Iron Works, Joshua.
Morse Bros. Mach. & Sup. Co.
Moyle Eng. & Equip. Co., E. H.
San Francisco Plating Wks.

Assayers' and Chemists' Directory
(See Index to Advertisers)

Assayers' and Chemists' Supplies
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Denver Fire Clay Co.
Dixon Crucible Co., Joseph.
Mine & Smelter Supply Co.

Balances and Weights
Ainsworth & Sons, Wm.
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Denver Fire Clay Co.
Mine & Smelter Supply Co.
Morse Bros. Mach. & Sup. Co.
Thompson Balance Co.

Ball Mills
(See "Mills")

Bearings
Dodge Sales & Eng. Co.
Meese & Gottfried Company.

Belting
Diamond Rubber Co., The.
Dodge Sales & Eng. Co.
Goodrich Co., The B. F.
Meese & Gottfried Company.
Price Pump & Engine Co.

Blowers
Allis-Chalmers Mfg. Co.
Denver Fire Clay Co.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Ingersoll-Rand Co.
Morse Bros. Mach. & Sup. Co.
Rix Comp. Air & Drill Co.

Boiler Graphite
Dixon Crucible Co., Joseph.

Boiler Valves
Powell, Wm., Co., The.

Boilers
Allis-Chalmers Mfg. Co.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Morse Bros. Mach. & Sup. Co.
Power & Mining Machy. Co.
Western Pipe & Steel Co.
Worthington Pump & Machy. Corp.

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Putman Boot & Shoe Co.

Brick, Fire
Atkins, Kroll & Co.
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Denver Fire Clay Co.

Brick, Magnesite
Refractory Magnesite Co.

Briquetting Machinery
Braun Corporation, The.
Braun-Knecht-Heimann Co.
General Briquetting Co.
Meese & Gottfried Company.
Traylor Eng. & Mfg. Co.

Briquetting Ores, Coal, Etc.
General Briquetting Co.

Brushes, Motor and Generator
Dixon Crucible Co., Joseph.
General Electric Co.
Westinghouse Electric & Mfg. Co.

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Allis-Chalmers Mfg. Co.
Atlas Car & Mfg. Co.
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Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Leschen & Sons Rope Co.
Meese & Gottfried Company.
New York Engineering Co.
Union Construction Co.
Watt Mining Car Wheel Co.
Wellman-Seaver-Morgan Co.
Western Gas Engine Corp.
Western Pipe & Steel Co.

Burners, Oil
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Denver Fire Clay Co.

Burners, Oil, Valves
Powell, Wm., Co., The.

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Broderick & Bascom Rope Co.
Fulton Engine Works.
Leschen & Sons Rope Co.
Lidgerwood Mfg. Co.
Morse Bros. Mach. & Sup. Co.
Sacramento Pipe Works.
Sauerman Bros.
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Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Morse Bros. Mach. & Sup. Co.
Traylor Eng. & Mfg. Co.
Wellman-Seaver-Morgan Co.

Carbons, Borts, and Diamonds
Atkins, Kroll & Co.
Diamond Drill Carbon Co.

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Atlas Car & Mfg. Co.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Mine & Smelter Supply Co.
Traylor Eng. & Mfg. Co.
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Wellman-Seaver-Morgan Co.
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American Cast Iron Pipe Co.

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Hendy Iron Works, Joshua.
Lunkenheimer Co., The.
Pacific Foundry Co.
Union Construction Co.
Western Gas Engine Corp.
Yuba Construction Co.

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Dodge Sales & Eng. Co.
Meese & Gottfried Company.

Chemicals
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Denver Fire Clay Co.
Dodge Sales & Eng. Co.
Mine & Smelter Supply Co.
Roessler & Hasslacher Chemical Co.

Chemical Castings
Pacific Foundry Co.
Western Gas Engine Corp.

Chilean Mills
(See "Mills")

Classifiers
Allis-Chalmers Mfg. Co.
Chalmers & Williams.
Colorado Iron Works Co.
Deister Machine Co.
Dorr Company, The.
Hendy Iron Works, Joshua.
Morse Bros. Mach. & Sup. Co.
Moyle Eng. & Equip. Co., E. H.
National Tank & Pipe Co.
Pacific Tank & Pipe Co.
Power & Mining Machy. Co.
Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Clutches, Friction
Dodge Sales & Eng. Co.
Meese & Gottfried Company.
Wellman-Seaver-Morgan Co.
Western Gas Engine Corp.

Coal Cutters
Allis-Chalmers Mfg. Co.
Ingersoll-Rand Co.

Coal Handling Machinery
Bartlett & Snow Co., C. O.
Dodge Sales & Eng. Co.
Meese & Gottfried Company.
Morse Bros. Mach. & Sup. Co.
Power & Mining Machy. Co.
Sullivan Machinery Co.
Worthington Pump & Machy. Corp.

Compressors, Air
Allis-Chalmers Mfg. Co.
Bessemer Gas Engine Co.
Chalmers & Williams.
Chicago Pneumatic Tool Co.
General Electric Co.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Ingersoll-Rand Co.
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Laidlaw-Dunn-Gordon Co.
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Rix Comp. Air & Drill Co.
Sullivan Machinery Co.
Western Gas Engine Corp.
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Diamond Rubber Co., The.
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Colorado Iron Works Co.
Deister Concentrator Co.
Deister Machine Co.
Eccleston Machinery Co.
Hendrie & Bolthoff Mfg. & Supply Co.
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Lane Mill & Machinery Co.
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Senn Concentrator Co.
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Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Concrete Mixers
Harron, Rickard & McCone.
Power & Mining Machy. Co.
Worthington Pump & Machy. Corp.

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Allis-Chalmers Mfg. Co.
Cameron Steam Pump Wks., A. S.
Ingersoll-Rand Co.
Worthington Pump & Machy. Corp.

Converters
Allis-Chalmers Mfg. Co.
Hendrie & Bolthoff Mfg. & Supply Co.
Power & Mining Machy. Co.
Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Conveyors, Belt or Screw
Allis-Chalmers Mfg. Co.
Dodge Sales & Eng. Co.
Goodrich Co., The B. F.
Harron, Rickard & McCone.
Meese & Gottfried Company.
Union Construction Co.

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Harron, Rickard & McCone.
Wellman-Seaver-Morgan Co.

Crucibles
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Denver Fire Clay Co.
Dixon Crucible Co., Joseph.
Harron, Rickard & McCone.
Mine & Smelter Supply Co.

Crushers
Allis-Chalmers Mfg. Co.
Bacon, Earle C.
Bartlett & Snow Co., C. O.
Braun Corporation, The.
Braun-Knecht-Heimann Co.
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Colorado Iron Works Co.
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Denver Quartz Mill & Crusher Co.
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Traylor Eng. & Mfg. Co.
Vulcan Iron Works.
Worthington Pump & Machy. Corp.

Cupels
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Denver Fire Clay Co.
Dixon Crucible Co., Joseph.
Mine & Smelter Supply Co.

Cyanide Plants and Machinery
Allis-Chalmers Mfg. Co.
Butters & Co., Ltd., Charles.
Chalmers & Williams.
Colorado Iron Works Co.
Dorr Company, The.
Hamillton, Beauchamp, Woodworth, Inc.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Kelly Filter Press Co.
Meese & Gottfried Company.
Mine & Smelter Supply Co.
Morse Bros. Mach. & Sup. Co.
Moyle Eng. & Equip. Co., E. H.
National Tank & Pipe Co.
Oliver Continuous Filter Co.
Pacific Tank & Pipe Co.
Power & Mining Machy. Co.
Redwood Manufacturers Co.
Stearns-Roger Mfg. Co.
Traylor Eng. & Mfg. Co.
Western Pipe & Steel Co.
Worthington Pump & Machy. Corp.

Dewaterers
Chalmers & Williams.
Colorado Iron Works Co.
Dorr Company, The.
Hendy Iron Works, Joshua.
Morse Bros. Mach. & Sup. Co.
Oliver Continuous Filter Co.
Traylor Eng. & Mfg. Co.

Distributers
Chalmers & Williams.
Colorado Iron Works Co.
Morse Bros. Mach. & Sup. Co
Moyle Eng. & Equip. Co., E. H.
National Tube Company.
Pacific Tank & Pipe Co.

Drafting Material
Ainsworth & Sons, Wm.

(Continued on Page 40)

Made in U. S. A.

Though there are many brands of

Rock Drill Steel

there is but one

"BULLDOG"

and it is the winner and holder of the

Blue Ribbon

Manufactured in all sizes and sections

Hollow and Solid

only by the

International High Speed Steel Co.

Works: Rockaway, N. J.

99 Nassau Street New York City

THERE is no room in business for the man or the machine that "gets tired and quits." The great, dominating, winning-thought is "see the thing through—*see it through successfully!*"

That's the basis on which every

MARION ELEVATOR DREDGE

is thought out, and laid out, and built—that it has a mighty task before it; and that it must "see the thing through" to a successful, *profitable* finish.

Witness the performance of "Marions" in every field, here and abroad, and you realize how fully this goal of ours is met in every machine that we build.

Marion

We Make Excavating Machinery of Every Description

Branches: Atlanta, Chicago, New York, San Francisco, Seattle

THE MARION STEAM SHOVEL COMPANY

Established 1884 MARION, OHIO

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Justrite TRADE MARK

CARBIDE Mine Lamp

"WHEN A BETTER CARBIDE LAMP IS MADE IT WILL BE A JUSTRITE"

Groping in the Dark

That is just what you are doing if you are working underground by candlelight.

The Best Light is the cheapest, and the cheapest is the Justrite, cheapest from every standpoint, quality and quantity of light, durability, economy, and freedom from trouble ordinarily incident to mine lighting.

This lamp, a Justrite No. 108 Half-Shift, saved $7666 in one year at an Arizona mine, by simply replacing candles, to say nothing of helping to make possible an increased tonnage output by reason of the vastly superior light.

WE MAKE A LAMP FOR EVERY MINING PURPOSE

Ask us to tell you how you can save money.
Write today.

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THE · BUYER'S · GUIDE

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Dragline Excavators
Broderick & Bascom Rope Co.
Fulton Engine Works.
Harron, Rickard & McCone.
Lidgerwood Mfg. Co.
Marion Steam Shovel Co.
Meese & Gottfried Company.
Sauerman Bros.
Union Construction Co.

Dredges
Marion Steam Shovel Co.
New York Engineering Co.
Price Pump & Engine Co.
Union Construction Co.
Yuba Construction Co.

Dredging Machinery
Hendrie & Bolthoff Mfg. & Supply Co.
Marion Steam Shovel Co.
New York Engineering Co.
Price Pump & Engine Co.
Union Construction Co.
Wellman-Seaver-Morgan Co.
Yuba Construction Co.

Drill Makers and Sharpeners
Denver Fire Clay Co.
Harron, Rickard & McCone.
Ingersoll-Rand Co.
Sullivan Machinery Co.
Wood Drill Works.

Drills, Air and Steam
Chicago Pneumatic Tool Co.
Denver Rock Drill Mfg. Co.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Ingersoll-Rand Co.
Mine & Smelter Supply Co.
Rix Comp. Air & Drill Co.
Sullivan Machinery Co.
Wood Drill Works.

Drills, Core
Harron, Rickard & McCone.
Ingersoll-Rand Co.
Sullivan Machinery Co.
Union Construction Co.

Drills, Diamond
Ingersoll-Rand Co.
Sullivan Machinery Co.

Drills, Electric
General Electric Co.
Ingersoll-Rand Co.

Drills, Prospecting
Harron, Rickard & McCone.
Ingersoll-Rand Co.
New York Engineering Co.
Rix Comp. Air & Drill Co.
Sullivan Machinery Co.
Union Construction Co.

Drills, Rock and Mining
International Highspeed Steel Co.

Dynamos
(See "Generators")

Employment Bureau
Business Men's Clearing House

Engineers
(See Professional Directory)

Engines, Gas and Gasoline
Allis-Chalmers Mfg. Co.
Bessemer Gas Engine Co.
Chicago Pneumatic Tool Co.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Lane Mill & Machinery Co.
Morse Bros. Mach. & Sup. Co.
Moyle Eng. & Equip. Co., E. H.
Power & Mining Machy. Co.
Price Pump & Engine Co.
Rix Comp. Air & Drill Co.
Western Gas Engine Corp.
Worthington Pump & Machy. Corp.

Engines, Oil
Allis-Chalmers Mfg. Co.
Bessemer Gas Engine Co.
Chicago Pneumatic Tool Co.
Harron, Rickard & McCone.
Ingersoll-Rand Co.
Morse Bros. Mach. & Sup. Co.
Price Pump & Engine Co.
Rix Comp. Air & Drill Co.
Snow Steam Pump Works.
Western Gas Engine Corp.
Worthington Pump & Machy. Corp.

Engines, Steam
Allis-Chalmers Mfg. Co.
Harron, Rickard & McCone.
Hendy Iron Works, Joshua.
Morse Bros. Mach. & Sup. Co.
Traylor Eng. & Mfg. Co.

Explosives
Du Pont Powder Co.
Hercules Powder Co.

Fans, Ventilating
Allis-Chalmers Mfg. Co.
General Electric Co.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Sullivan Machinery Co.

Filters
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Chalmers & Williams.
Colorado Iron Works Co.
Morse Bros. Mach. & Sup. Co.
Oliver Continuous Filter Co.
Traylor Eng. & Mfg. Co.

Filter Bags
Filter Fabrics Co.

Filter Presses
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Harron, Rickard & McCone.
Kelly Filter Press Co.
Morse Bros. Mach. & Sup. Co.
Power & Mining Machy. Co.
Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Fire Brick
Atkins, Kroll & Co.
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Denver Fire Clay Co.

Fire Extinguishers
Bullard, E. D.
Justrite Mfg. Co.

First Aid Equipment
Bullard, E. D.
Siebe, Gorman & Co., Ltd.

Flotation Apparatus
Denver Fire Clay Co.
Filter Fabrics Co.
Rix Comp. Air & Drill Co.
Stimson Equipment Co.

Flotation Process
Butters & Co., Ltd., Charles.
Hamilton, Beauchamp, Woodworth, Inc.
Stimson Equipment Co.

Foundry Equipment
Dixon Crucible Co., Joseph.
Ingersoll-Rand Co.
Sullivan Machinery Co.
Wellman-Seaver-Morgan Co.

Forges
Hendrie & Bolthoff Mfg. & Supply Co.
Ingersoll-Rand Co.
Mine & Smelter Supply Co.
Sullivan Machinery Co.

Frogs and Switches
(See "Railway Supplies")

Furnaces, Assay
(See Assayers' and Chemists' Supplies)

Furnaces, Roasting and Smelting
Allis-Chalmers Mfg. Co.
Colorado Iron Works Co.
Denver Fire Clay Co.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Morse Bros. Mach. & Sup. Co.
Pacific Foundry Co.
Power & Mining Machy. Co.
Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Gas Producers
Atlas Car & Mfg. Co.
Power & Mining Machy. Co.
Wellman-Seaver-Morgan Co.

Gaskets
(See "Packing")

Gears
Dodge Sales & Eng. Co.
General Electric Co.
Hendy Iron Works, Joshua.
Meese & Gottfried Company.
Western Gas Engine Corp.

Generators
Allis-Chalmers Mfg. Co.
General Electric Co.
Hendrie & Bolthoff Mfg. & Supply Co.
Morse Bros. Mach. & Sup. Co.
Westinghouse Electric & Mfg. Co.

Giants, Hydraulic
(See Hydraulic Mining Mach.)

Graphite Products
Dixon Crucible Co., Joseph.

Grease, Lubricating
Albany Lubricating Co.

Hammer Drills, Pneumatic
Chicago Pneumatic Tool Co.

Heaters, Feed Water
Allis-Chalmers Mfg. Co.
Dodge Sales & Eng. Co.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Morse Bros. Mach. & Sup. Co.
Worthington Pump & Machy. Corp.

Hoists, Electric
Allis-Chalmers Mfg. Co.
Bartlett & Snow Co., C. O.
Fulton Engine Works.
General Electric Co.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Lidgerwood Mfg. Co.
Morse Bros. Mach. & Sup. Co.
Power & Mining Machy. Co.
Price Pump & Engine Co.
Rix Comp. Air & Drill Co.
Sullivan Machinery Co.
Traylor Eng. & Mfg. Co.
Wellman-Seaver-Morgan Co.
Westinghouse Electric & Mfg. Co.
Worthington Pump & Machy. Corp.

Hoists, Oil and Distillate
Western Gas Engine Corp.

Hoists, Steam or Air
Allis-Chalmers Mfg. Co.
Chicago Pneumatic Tool Co.
Fulton Engine Works.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Lidgerwood Mfg. Co.
Morse Bros. Mach. & Sup. Co.
Power & Mining Machy. Co.
Price Pump & Engine Co.
Rix Comp. Air & Drill Co.
Sullivan Machinery Co.
Wellman-Seaver-Morgan Co.
Worthington Pump & Machy. Corp.

Hose
Chicago Pneumatic Tool Co.
Denver Rock Drill Mfg. Co.
Diamond Rubber Co., The.
General Electric Co.
Goodrich Co., The B. F.
Harron, Rickard & McCone.
Ingersoll-Rand Co.
Rix Comp. Air & Drill Co.

Hose Couplings
Chicago Pneumatic Tool Co.
Ingersoll-Rand Co.
National Tube Company.
Powell, Wm., Co., The.
Rix Comp. Air & Drill Co.
Wood Drill Works.

Hydraulic Mining Machnery
Allis-Chalmers Mfg. Co.
American Spiral Pipe Wks.
Harron, Rickard & McCone.
Hendy Iron Works, Joshua.
Moyle Eng. & Equip. Co., E. H.
New York Engineering Co.
Pelton Water Wheel Co.
Price Pump & Engine Co.
Sacramento Pipe Works.
Worthington Pump & Machy. Corp.

Hydraulic Valves
Powell, Wm., Co., The

Injectors
Lunkenheimer Co., The.
Morse Bros. Mach. & Sup. Co.
National Tube Company.
Powell, Wm., Co., The.

Iron Cements
Smooth-On Mfg. Co.

Jigs
Allis-Chalmers Mfg. Co.
Chalmers & Williams.
Colorado Iron Works Co.
Harron, Rickard & McCone.
Hendy Iron Works, Joshua.
Morse Bros. Mach. & Sup. Co.
Power & Mining Machy. Co.
Stearns-Roger Mfg. Co.
Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Laboratory Supplies
(See Assayers' and Chemists' Supplies)

Lamps, Arc and Incandescent
General Electric Co.
Westinghouse Electric & Mfg. Co.

Lamps, Miners
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Bullard, E. D.
General Electric Co.
Harron, Rickard & McCone.
Justrite Mfg. Co.

Lead Joint Pipe
National Tube Company.

Locomotives, Electric
American Locomotive Co.
Atlas Car & Mfg. Co.
General Electric Co.
Harron, Rickard & McCone.
Morse Bros. Mach. & Sup. Co.
Westinghouse Electric & Mfg. Co.

Locomotives, Steam
American Locomotive Co.
Harron, Rickard & McCone.
Morse Bros. Mach. & Sup. Co.

Lubricants
Albany Lubricating Co.
Dixon Crucible Co., Joseph.
Harron, Rickard & McCone.
Powell, Wm., Co., The.

Lubricators
Albany Lubricating Co.
Dodge Sales & Eng. Co.
Harron, Rickard & McCone.
Lunkenheimer Co., The.

Machinery, Used
Morse Bros. Mach. & Sup. Co.

Magnesite
Atkins, Kroll & Co.
Braun-Knecht-Heimann Co.
Refractory Magnesite Co.

Metal Buyers and Dealers
American Metal Co.
American Zinc, Lead & Smelting Co.
Atkins, Kroll & Co.
Beer, Sondheimer & Co.
Consolidated Min. & Smelt. Co. of Canada, Ltd.
Edgar Zinc Company.
Empire Zinc Co.
Granby Min. & Smelt. Co.
International Smelting Co.
Selby Smelting & Lead Co.
U. S. Smelting, Refining & Mining Co.
Vogelstein & Co., L.
Wah Chang M. & S. Co., Ltd.
Wildberg Bros.

Meters—Flow, Air, Gas, Water
General Electric Co.
Rix Comp. Air & Drill Co.
Worthington Pump & Machy. Corp.

Mills—Ball, Pebble and Tube
Allis-Chalmers Mfg. Co.
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Bullard, E. D.
Chalmers & Williams.
Colorado Iron Works Co.
Eccleston Machinery Co.
Hardinge Conical Mill Co.
Harron, Rickard & McCone.
Hendy Iron Works, Joshua.
Johnson Engineering Wks.
Mine & Smelter Supply Co.
Morse Bros. Mach. & Sup. Co.
New York Engineering Co.
Power & Mining Machy. Co.
Price Pump & Engine Co.
Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Mills, Chilean
Allis-Chalmers Mfg. Co.
Chalmers & Williams.
Colorado Iron Works Co.
Denver Quartz Mill & Crusher Co.
Harron, Rickard & McCone
Hendy Iron Works, Joshua.
Lane Mill & Machinery Co.
Morse Bros. Mach. & Sup. Co
Power & Mining Machy. Co

(Continued on Page 42)

STANDARD DESIGN LOCOMOTIVES

Our standard design locomotives are built for hard work and to earn the maximum money for the owner.

These locomotives are built to operate at a distance from shops and facilities for repairs. They are simple in construction, with every part specially adapted to the demands upon it. This applies not only to the strength, but to the wearing qualities and accessibility for inspection and renewal.

We can make immediate shipment of locomotives of various sizes.

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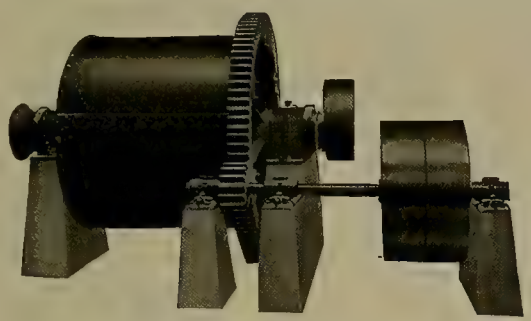

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No inside screens, lifting devices or features to give trouble. Lining is self locking, no bolts through the shell, maximum wear of lining. Lining made of special manganese, the most durable made. Scoop feed with renewable steel wearing lips. Trunions equipped with spiral feed and reverse spiral discharge. Made in all sizes.

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5x4 Ball charge, 6000 lbs.; H.P., 40; capacity crusher product to 12 mesh, 10 tons per hour; weight, 13,500 lbs.

4x3 Ball charge, 2300 lbs.; H.P., 15; capacity crusher product to 12 mesh, 3 tons per hour; weight, 8750 lbs.

Laboratory and sample mill, either ball or pebble; 250 lbs. to charge. Kept in stock.

The Morse Bros. Machinery & Supply Co.

Denver, Colorado

B&B AERIAL TRAMWAYS

The Shortest Distance Between Two Points

Ore from Mine to Mill without interruption or delay

is assured to users of

B & B AERIAL TRAMWAYS

The two-bucket system for small and medium capacities is simplicity itself. It is operated by one man and reduces haulage costs to but a few cents per ton.

Whatever your present method of mine transportation, write us. It will pay you.

BRODERICK & BASCOM ROPE CO.

St. Louis, Mo.

THE · BUYER'S · GUIDE

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Worthington Pump & Machy. Corp.

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General Electric Co.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Mine & Smelter Supply Co.
Morse Bros. Mach. & Sup. Co.
Price Pump & Engine Co.
Westinghouse Electric & Mfg. Co.

Oil and Grease Cups
(See "Lubricators")

Oil Well Supplies
Bessemer Gas Engine Co.
Diamond Rubber Co., The.
Hendy Iron Works, Joshua.
National Tube Company.
Powell, Wm., Co., The
U. S. Steel Products Co.

Oil, Flotation
General Naval Stores Co.
Pensacola Tar & Turpentine Co.

Ore Bins
Hammond Iron Works.
Western Pipe & Steel Co.

Ore Buyers
(See Metal Buyers and Dealers)

Oxy-Acetylene Welding and Cutting Apparatus
Bullard, E. D.

Oxygen Apparatus
Bullard, E. D.
Siebe, Gorman & Co., Ltd.

Packing
Diamond Rubber Co., The.
Smooth-On Mfg. Co.

Paint, Preservative
Dixon Crucible Co., Joseph.

Patent Attorneys
Dewey, Strong & Townsend.

Pebbles
Atkins, Kroll & Co.
Hardinge Conical Mill Co.
Harron, Rickard & McCone.

Perforated Metals
Allis-Chalmers Mfg. Co.
Hendy Iron Works, Joshua.
Ludlow-Saylor Wire Co.
Meese & Gottfried Company.

Pipe Fittings
American Metal Co.
Lunkenheimer Co., The.
National Tube Company.
Pacific Foundry Co.
Pacific Tank & Pipe Co.
Powell, Wm., Co., The
Sacramento Pipe Works.
Smith, S. Morgan.
Western Pipe & Steel Co.

Pipe, Air
Ames-Irvin Co.

Pipe, Iron
American Cast Iron Pipe Co.

Pipe, Riveted
American Spiral Pipe Wks.
Hendy Iron Works, Joshua.
New York Engineering Co.
Sacramento Pipe Works.
Smith, S. Morgan.
Western Pipe & Steel Co.

Pipe, Steel
American Spiral Pipe Wks.
Moyle Eng. & Equip. Co., E. H.
New York Engineering Co.
Sacramento Pipe Works.
Western Pipe & Steel Co.

Pipe, Wood
National Tube Company.
Pacific Tank & Pipe Co.
Redwood Manufacturers Co.

Placer Mining Machinery
American Spiral Pipe Wks.
Fulton Engine Works.
Harron, Rickard & McCone.
Hendy Iron Works, Joshua.
Marion Steam Shovel Co.
Morse Bros. Mach. & Sup. Co.
Moyle Eng. & Equip. Co., E. H.
New York Engineering Co.
Pelton Water Wheel Co.
Price Pump & Engine Co.
Sauerman Bros.
Senn Concentrator Co.
Union Construction Co.
Yuba Construction Co.

Pneumatic Tools
Chicago Pneumatic Tool Co.

Powder
Du Pont Powder Co.
Hercules Powder Co.

Preservatives, Wood
General Naval Stores Co.
Pensacola Tar & Turpentine Co.

Preservatives, Metal
Dixon Crucible Co., Joseph.

Prospecting Supplies
Braun Corporation, The.
Denver Fire Clay Co.
Harron, Rickard & McCone.
Mine & Smelter Supply Co.
Moyle Eng. & Equip. Co., E. H.
New York Engineering Co.
Rix Comp. Air & Drill Co.

Pulleys, Shafting and Hangers
(See "Transmission Machinery")

Pulverizers
Allis-Chalmers Mfg. Co.
American Metal Co.
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Chalmers & Williams.
Colorado Iron Works Co.
Denver Fire Clay Co.
Denver Quarts Mill & Crusher Co.
Hardinge Conical Mill Co.
Hendy Iron Works, Joshua.
Lane Mill & Machinery Co.
Mine & Smelter Supply Co.
Moyle Eng. & Equip. Co., E. H.
Power & Mining Machy. Co.
Price Pump & Engine Co.
Traylor Eng. & Mfg. Co.
Wellman-Seaver-Morgan Co.
Worthington Pump & Machy. Corp.

Pumps, Centrifugal
Allis-Chalmers Mfg. Co.
Cameron Steam Pump Wks., A. S.
Deane Steam Pump Co.
Deming Co., The.
Frenier & Son.
General Electric Co.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Jackson Iron Works, Byron.
Krogh Pump Mfg. Co.
Meese & Gottfried Company.
Mine & Smelter Supply Co.
Morse Bros. Mach. & Sup. Co.
Oliver Continuous Filter Co.
Price Pump & Engine Co.
Rix Comp. Air & Drill Co.
Snow Steam Pump Works.
Worthington Pump & Machy. Corp.
Yuba Construction Co.

Pumps, Reciprocating
Allis-Chalmers Mfg. Co.
Cameron Steam Pump Wks., A. S.
Deane Steam Pump Co.
Deming Co., The.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Laidlaw-Dunn-Gordon Co.
Mine & Smelter Supply Co.
Morse Bros. Mach. & Sup. Co.
Price Pump & Engine Co.
Rix Comp. Air & Drill Co.
Snow Steam Pump Works.
Worthington Pump & Machy. Corp.

Pumps, Air Lift
Price Pump & Engine Co.
Sullivan Machinery Co.

Pumps, Vacuum
Cameron Steam Pump Wks., A. S.
Pacific Tank & Pipe Co.
Price Pump & Engine Co.
Rix Comp. Air & Drill Co.

Quicksilver
Atkins, Kroll & Co.
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Mine & Smelter Supply Co.

Quicksilver Furnaces
Hendy Iron Works, Joshua.

Railway Supplies ad Equipment
American Locomotive Co.
Atlas Car & Mfg. Co.
Harron, Rickard & McCone.
U. S. Steel Products Co.
Watt Mining Car Wheel Co.

Reheaters
Chicago Pneumatic Tool Co.

Rescue Apparatus
Bullard, E. D.
Elmer, H. N.
Siebe, Gorman & Co., Ltd.

Rolls, Crushing
Atlas Car & Mfg. Co.
Bacon, Earle C.
Bartlett & Snow Co., C. O.
Chalmers & Williams.
Colorado Iron Works Co.
Denver Quarts Mill & Crusher Co.
Harron, Rickard & McCone.
Hendrie & Bolthoff Mfg. & Supply Co.
Hendy Iron Works, Joshua.
Lane Mill & Machinery Co.
Meese & Gottfried Company.
Morse Bros. Mach. & Sup. Co.
Power & Mining Machy. Co.
Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Rope, Manila and Jute
Dodge Sales & Eng. Co.
Harron, Rickard & McCone.
Leschen & Sons Rope Co.
Meese & Gottfried Company.

Rope, Wire
American Steel & Wire Co.
Broderick & Bascom Rope Co.
Dodge Sales & Eng. Co.
Leschen & Sons Rope Co.
Meese & Gottfried Company.
Sauerman Bros.
U. S. Steel Products Co.

Safety Appliances
Bullard, E. D.
Harron, Rickard & McCone.
Siebe, Gorman & Co., Ltd.

Samplers
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Chalmers & Williams.
Colorado Iron Works Co.
Denver Fire Clay Co.
Harron, Rickard & McCone.
Mine & Smelter Supply Co.
Morse Bros. Mach. & Sup. Co.
Traylor Eng. & Mfg. Co.

Saw Mill Machinery
Harron, Rickard & McCone.
Hendy Iron Works, Joshua.
Meese & Gottfried Company.

Schools and Colleges
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Screens
Allis-Chalmers Mfg. Co.
Bartlett & Snow Co., C. O.
Braun Corporation, The.
Braun-Knecht-Heimann Co.
Cal. Perforated Screen Co.
Chalmers & Williams.
Colorado Iron Works Co.
Hendy Iron Works, Joshua.
James Ore Concentrator Co.
Ludlow-Saylor Wire Co.
Meese & Gottfried Company.
Moyle Eng. & Equip. Co., E. H.
Power & Mining Machy. Co.
Traylor Eng. & Mfg. Co.
Worthington Pump & Machy. Corp.

Second-Hand Machinery
Morse Bros. Mach. & Sup. Co.

Shafting
(See "Transmission Machy.")

Shoes and Dies
Chalmers & Williams.
Harron, Rickard & McCone.
Hendy Iron Works, Joshua.
Traylor Eng. & Mfg. Co.

Shovels, Electric and Steam
Marion Steam Shovel Co.

Silex
Atkins, Kroll & Co.
Hardinge Conical Mill Co.

Smelters and Refiners
American Zinc, Lead & Smelting Co.
Beer, Sondheimer & Co.
Consolidated Min. & Smelt Co. of Canada, Ltd.
Empire Zinc Co.
Granby Min. & Smelt. Co.
International Smelting Co.
Selby Smelting & Lead Co.
U. S. Smelting, Refining & Mining Co.
Vogelstein & Co., L.
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(Continued on page 43)

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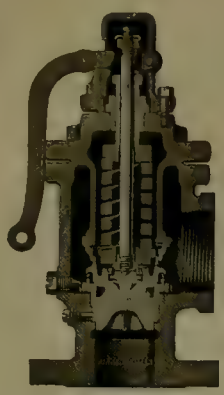
Pop Safety Valves

Encased and Exposed Spring Types

Material Combinations to suit all Service Conditions

Absolute safety from the danger of over-pressure when boilers are equipped with these valves. There is likewise the greatest economy because the "pop" can be regulated to suit individual requirements, and this without taking the valve apart.



The disc will not stick, chatter or hammer. It is guided both above and below the seat, carries the spring load on a point contact in the center and is cushioned when seating by the action of the "pop", thereby reducing wear to a minimum.

The non-distorting seat ring (an exclusive Lunkenheimer feature) is not affected by temperature changes. Should the seating surfaces become worn they can easily be reground.

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The materials used and the workmanship are of characteristic Lunkenheimer "Quality."

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Cameron Centrifugals

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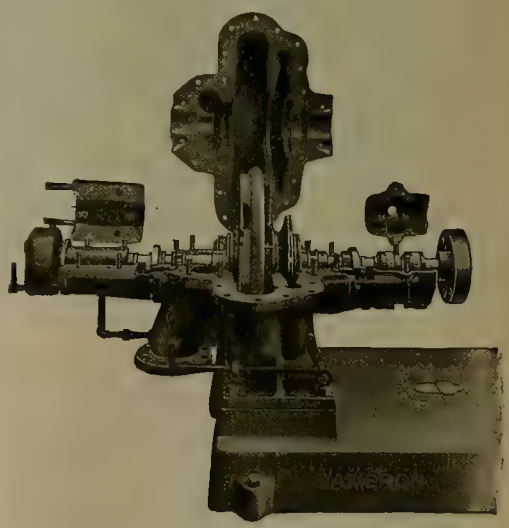

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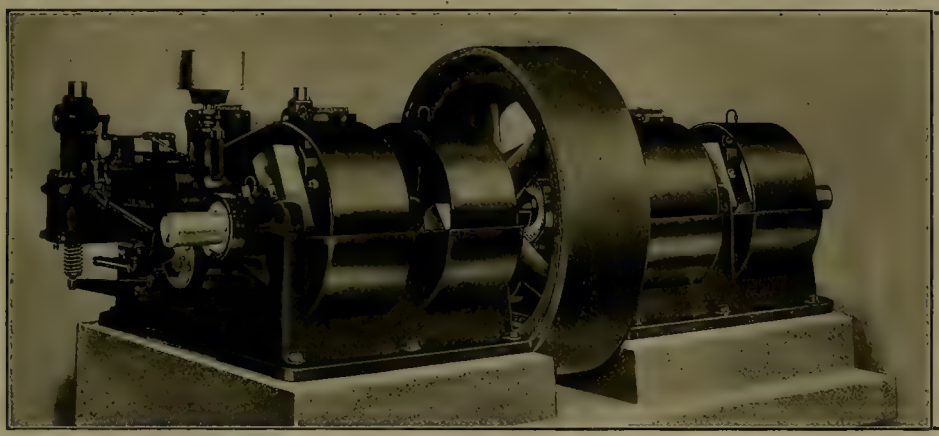

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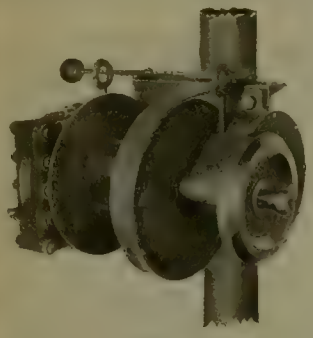

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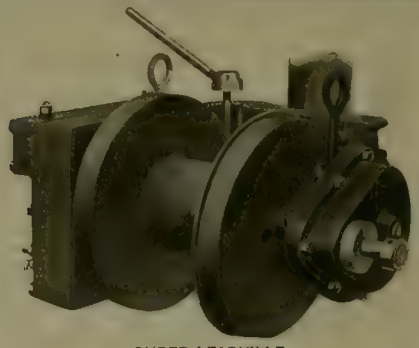

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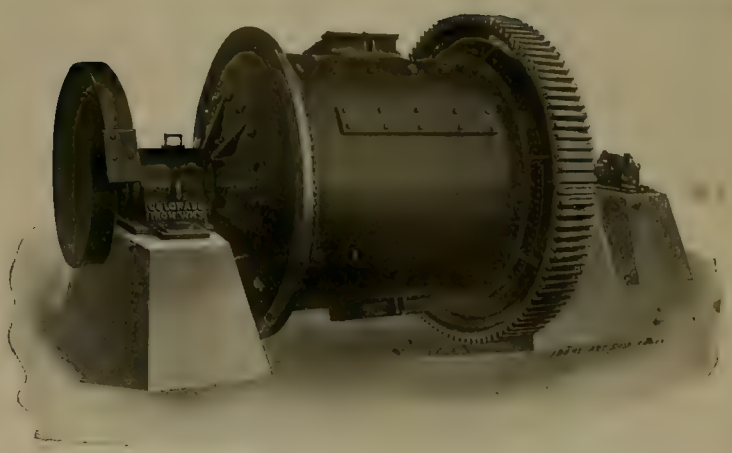

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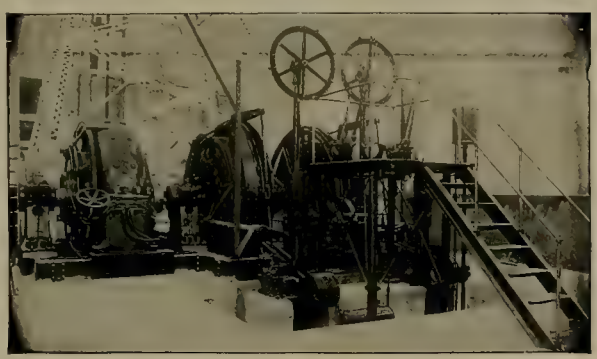

6 Hoist Furnished Silver King Coalition Mines Co., Park City, Utah.

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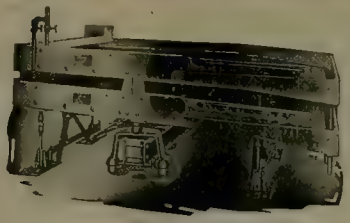

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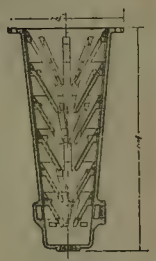

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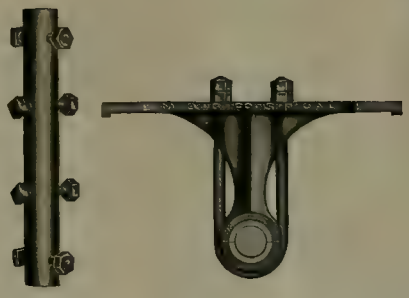

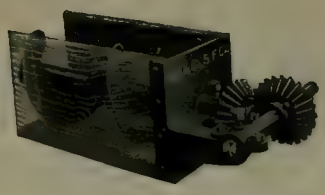

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Mining and Scientific Press

Edited by T. A. RICKARD

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SAN FRANCISCO, JANUARY 13, 1917

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T. A. RICKARD - - Editor
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W. H. STORMS }

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SPECIAL CONTRIBUTORS
W. H. Shockley.
Leonard S. Austin.
Gelasio Caetani.
Courtenay De Kalb.
F. Lynwood Garrison.
Charles Janin.
James F. Kemp.
F. H. Probert.
C. W. Purington.
Horace V. Winchell.

Science has no enemy save the ignorant

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UNION CONSTRUCTION COMPANY

The Union Construction Page

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of
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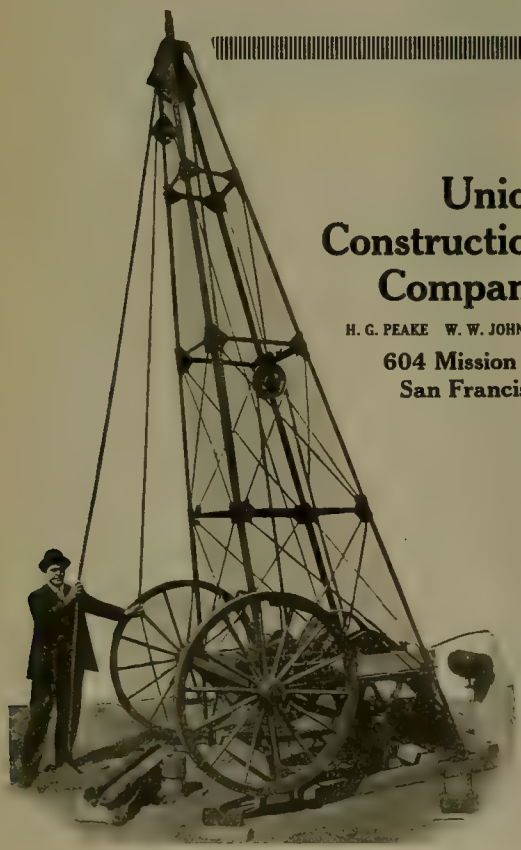

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EDITORIAL

T. A. RICKARD, Editor

THOMAS W. LAWSON has revived his hippodrome, and Congress is the principal performer. The talk of a 'remedy' sounds like the echo of a familiar fake.

IN our issue of December 30, the "profit" of the Miami Copper Company on ore treated by flotation should have been "value of concentrate" resulting from this treatment.

DIVIDENDS aggregating $100,000,000 were paid in 1916 by the mines in five of our Western States—Arizona, Utah, Montana, Nevada, and Idaho. Arizona alone contributed $34,000,000 to the owners of mines. Every western State shows an increase of metal output and Alaska contributed $50,000,000 or 50% in excess of the previous year.

AT this season of the year the average man is deluged with statistics that exhaust his fund of wonderment. To those that follow the growth of industry in a great country like this the big totals are not stupifying. When 100,000,000 active and energetic people do anything, whether it be eating candy or producing copper, the statistical record is bound to run into tremendous figures.

MANY ways have been suggested of filling stopes—with waste-rock broken underground, with tailing-sand and other materials taken from the surface, but the latest suggestion comes from an ingenious fellow who proposes to fill mine excavations with ice. He has secured a patent on this cool idea. We don't like it; it would work against the minority shareholders, for it might facilitate a freeze-out.

CALIFORNIA did well in 1916. The gross metal output increased by $12,000,000 or 38%. The yield of gold was the largest in 33 years, the silver output advanced 69% in value, value of the copper output was 140% bigger, and the lead value was 335% greater, while zinc more than held its own, improving 22% in value. Dredging contributed 90% of the total alluvial gold. We published the details in our last issue, as compiled by Mr. Charles G. Yale, statistician to the Geological Survey.

SPELTER production in 1916, according to the U. S. Geological Survey, was 658,000 tons, as compared with 489,519 tons in 1915. The domestic consumption increased from 364,382 to 445,000 tons and the export from 132,323 to 210,500 tons. Thus production increased 34%, exports 59%, and domestic consumption 22%. In 1913 the production was 346,676 tons, the consumption 295,270 tons, and the export only 7783 tons. The number of retorts in service was 213,840 at the end of 1916, and 13,648 more are being built or planned. This will represent an increase of 70,920 retorts since the end of 1915. At the average of 13.7 cents per pound the total production was worth $180,000,000, as compared with a valuation of $121,000,000 in the preceding year.

COPPER mining gave its supporters $157,000,000 in the form of dividends in 1916, the largest distributor being the Utah Copper Company, which paid $19,000,000. Kennecott was second and Anaconda third. In the last month of the year the disseminated-copper mines paid an aggregate of $33,000,000 in dividends. To the gains from copper-mining must be added the dividends of the big metallurgical companies that also operate copper mines, making the total winnings from this branch of the mining industry about $175,000,000.

SCARCITY of cyanide is tending to restrict the production of silver, particularly in Mexico. This important chemical is now selling for 75 cents per pound and is difficult to get even at that high price. The Glasgow maker of cyanide is restricting his dealings to mining companies within the British empire and the New Jersey manufacturer is supplying far too little to fill the requirements of mills in the United States and Mexico. The decrease in the recovery of silver by cyanidation is diminishing the output of the metal and is one reason for the rise in price. 'Dollar silver' is not unlikely during 1917, for the expense of maritime transport has been increased by the advance of insurance and the purchases of the metal for coinage by the Entente nations is making insistent demands on the supply. The saving of silver by the poorer people of Europe during the War may have some of the effects so long noted from similar hoarding in the Orient.

REFERENCE to two technical articles, published in old volumes of a leading technical society, prompts a protest. We had to read the articles in order to extract some information and we found them most difficult to understand because, apart from being badly written, they contained a variety of weights and measures. In one of them milreis, pounds, shillings, pence, metres, feet, inches, kilograms (written "k."), grams (written "grm."), ounces, and grains made a nightmare of confusion and the text was (we use the past tense because we want to forget it) sprinkled with such illuminating terms as *lapa, canga,* and *passador.* In the other article the weights were given in dry and wet tons, in metric

tons and in short tons, while money-values were stated in pounds, dollars, and Mexican dollars (meaning 'pesos') until the reader cursed the tower of Babel and the laziness of writers that will not reduce weights and measures to a common standard, and the one his readers are most likely to know.

AS if we had not troubles enough, we are importuned by a circular from the office of the Institute to vote on simplified spelling, in consequence of a petition presented by a number of honorable members, a suspiciously large proportion of whom live at or near Palo Alto, California. Being a Sherlock Holmes in our own quiet way, we can infer who was the member that conspired to bother us with this spelling propaganda. If the petition is endorsed, we shall proffer our sincere sympathy to Mr. Bradley Stoughton and his staff; meanwhile we rejoice that no faddists can compel us to mutilate the official language of the United States.

EXPORT returns for the first ten months of 1916 indicate the stimulating effect of the War on the metal trade. Aluminum comes first in alphabetic order and it is also the metal exhibiting the greatest gain in exportation, for during the period specified the exports were valued at $9,542,030, as against $3,069,270 and $897,569 respectively in the corresponding periods of 1915 and 1914. Much of this trade has been prompted by the employment of aluminum dust for combination with ammonium nitrate to make the new and deadly explosive called ammonal. Other comparative statistics of metals and manufactures of them are as follows:

	1916	1914
Copper	$188,866,885	$103,671,870
Zinc	48,451,130	4,713,944
Lead	14,677,387	4,486,310
Nickel	11,556,454	8,392,042

Brass manufactures, in which so much copper and zinc were consumed, were exported to the value of $263,337,207 during the ten months of 1916, as against only $5,336,794 in the same time during 1915. These brass exports were 50 times larger than in 1914. Most of this was the direct result of the business in shells and other munitions.

FROM London we learn that the great lawsuit, which occupied 144 days and in which counsel for the defense made a speech 45 days long, has been decided. The Globe & Phoenix Gold Mining Company wins. It is said that the Judge's life was insured for $150,000 against the risk of the case being re-heard. That may be a pleasantry, but the cost of the action—$500,000—is not. An appeal is threatened by the plaintiff and loser, the Amalgamated Properties of Rhodesia. After spending a vast amount of time in hearing evidence on the extra-lateral right phase of the argument and listening to a mass of geological and pseudo-geological testimony, the Court brushes all these mining technicalities aside and decides the case on the terms of the agreement between the two companies, giving the possessor of the claims the benefit of the proverbial nine points of the law. The mine has been worked for 20 years, so that much of the necessary evidence regarding the vein-structure has been obscured or removed. The old dispute as between the junction of veins and the branching of a main vein called forth discrepant opinions and observations from witnesses of varying positiveness. The giving of the wrong color to a particular vein on a map and the assumption by some of the witnesses that this was a separate lode-unit is stated by the Judge to have misled the plaintiff's experts into trying "to convert an impression into a conviction." All this sounds a familiar note. The immediate result was to debase Amalgamated shares to 6 cents and to elevate Globe & Phoenix to $9 per share, as against previous prices, last year, of 43 cents and $5, respectively. Incidentally the study of structural geology in the gold mines of Rhodesia has been stimulated.

The Flotation Crisis

A month has elapsed since the Supreme Court's decision giving Minerals Separation the right to collect royalty from those using less than 1% of oil in a process for making a mineral-bearing froth by means of beating air into a metallurgic pulp. That decision emphasizes the "critical" proportion of oil essential to the success of the operation and sustains only the claims that specify the quantity of oil as "a fraction of 1%," invalidating the three claims in which "a small quantity" is mentioned. Parenthetically, it is worthy of remark that the Court states that the process of patent 835,120 "was immediately generally accepted as so great an advance over any process known before that . . . it promptly came into extensive use . . . in most, if not all, of the principal mining countries of the world, notably in the United States." The fact is that the process did not come into use in the United States until six years after the grant of patent, and as late as the same year—1911—the Minerals Separation people stated that ores containing copper in the form of chalcocite were not amenable to their process. The Court refers to "the Elmore oil flotation process" as "typical of the then prior art" and makes the mistake of ignoring the fact that the old bulk-oil process had been discarded at least ten years ago, while at the same time no reference is made to the Elmore air-oil process that was patented a year before Minerals Separation's principal patent, 835,120, and was put into extensive and successful use in many parts of the world. It is extraordinary how this blunder of confusing Elmore's two methods, one metallurgically a failure and the other a success, one dated 1898 and the other 1904, has been repeated again and again in technical literature and in the courts. There never has been a legal test between Minerals Separation's froth-agitation patent and that of the Elmore vacuum patent. To us it seems astonishing that the opposers of Minerals Separation's effort, now temporarily successful, to obtain a monopoly of rights to the use of flotation, should have failed to avail themselves of Elmore's priority in the use of air with a

small proportion of oil, reduced finally to as little as three pounds per ton of ore. Wisdom after the event was never better illustrated than in the purchase of Elmore's air patents by Messrs. Jackling, Channing, and others for $75,000 in 1915 instead of doing so before the Hyde and Miami lawsuits were started. It would have been cheaper to buy them for $750,000 before the litigation had progressed so far. We understand that the Butte & Superior and Miami controllers were loth to establish Mr. Francis E. Elmore's rights and so exchange one patent-monopoly for another, but it should have been possible to settle with Mr. Elmore and his backers before doing so, thereby giving themselves a better chance to win against Minerals Separation. Now the Elmore vacuum patent is mentioned as a means of reprisal and a suit for infringement is likely to be brought against Minerals Separation—reversing the tables. So

"Chaos umpire sits
And by decision more embroils the fray."

We hope that a suit will be started, if it offers any chance of a more reasonable attitude on the part of the patent-owners. To somebody the users of flotation ought to pay tribute for the use of this wonderful process. It is the harshness of Minerals Separation's policy that has evoked so much antagonism, more particularly the effort to bind metallurgists hand and foot and the attempt to place an embargo upon technical information. A royalty of 10 cents per ton on base-metal ores and of 25 cents per ounce of gold should be paid cheerfully by any user of flotation to the inventor of the process. We do not regard the Court's decision in the matter as acceptable, however correct on the evidence submitted to it. As a detached, but not ignorant, onlooker we would give 4 cents to Minerals Separation, 3 cents to Elmore, 2 cents to Froment's widow, and 1 cent per ton to the Belgian Relief Commission. That might be called an equitable distribution of another man's property.

The Presidency of the Institute

In the December bulletin of the Institute it was announced that the Committee on Nominations, while naming Mr. Sidney J. Jennings for President, regretted its inability, by the terms of the constitution, to nominate another candidate, because it would have liked to name Mr. Philip N. Moore also. It was stated that both gentlemen had received many cordial endorsements and in view of these facts the Committee suggested that Mr. Moore be nominated by petition of 25 members in accordance with the present constitution. The Board of Directors has expressed no preference for either candidate. The Committee, however, intimates that "the nominations are largely controlled by a small group and that the members at large can have little influence." This was the very condition of affairs that the re-organization four years ago was intended to obviate, but it is only fair to add that the chairman of the Committee is a Californian engineer of enviable reputation and there is no reason whatever to believe that the nominations were influenced from New York. Owing to the confusion created in the first place by the early electioneering in behalf of one candidate and the later campaigning for the other, a kind of competition has been aroused that can do no good to either candidate or to the Institute. The circular issued by the friends of Mr. Jennings is in bad taste; a possible President should need no touting—Mr. Jennings needs none; his photograph should not be used like that of a candidate for town-constable; moreover, the reference to his ability to ensure "the co-operation of great business enterprises" is unfortunate, because the friends of Mr. Moore have animadverted on the corporation tie, just as the other side has referred to the controversy of four years ago—the movement for reform—in which Mr. Moore played a useful part. In the circular issued by four of the reformers—we speak of friends with whom we are in sympathy—advocating the election of Mr. Moore, it is stated that he was endorsed by a much greater number than Mr. Jennings and members are reminded that the next summer meeting is to be held at St. Louis, where Mr. Moore lives, as another reason for giving him the vote. These are the facts. We have received several letters from engineers of high standing expressing chagrin that the election should have assumed a cheap political character, that either candidate should so strive to obtain the honor, and that an old feud should be revived. We echo these regrets. The presidency should come to a man as an unsolicited honor; it is not the kind of distinction that should be put up to competition, because it is not a dignity for which a man should compete. While it may seem desirable to give the membership at large a chance to express their individual opinions, we doubt whether that can be done usefully. Not many men of presidential rank would be willing to run a race in popularity against a member of their own standing. One cannot imagine James Douglas or James F. Kemp consenting to compete against each other. Putting the argument on a lower plane, most self-respecting men would be unwilling to run the risk of being defeated in such a public contest even by an admittedly eminent compeer. The Presidency is not a political office; it is an honorable appointment made by a committee of engineers selected for their ability to make a proper choice. The Presidency is now no longer a sinecure; it involves work and personal expense, because the holder of the office must attend frequent meetings of the directorate and of committees at headquarters. That is why, inevitably, the president will be more often a resident in New York and its vicinity than a Western engineer or metallurgist. Few men not under retainer to the big corporations or otherwise in their employ are likely to have the time and opportunity to accept the responsibilities of the position. That is why, prejudiced as we ourselves are against any corporate influence in professional affairs, we recognize that the corporation slur is unwarranted, except for specific reasons. It is a pity that the honor must go to rich men or to those that are highly salaried, but that is the way of the world, and fortunately

a comfortable bank account need not kill ethical ideas or professional ideals. So, while we would like to have seen Mr. Moore elected because he is a Western engineer and because his name was mentioned for the presidency two years ago, we do not hesitate to advise the members of the Institute to vote for the regular nominee and we hope most sincerely that Mr. Moore will set aside any personal resentment aroused by the untoward train of events and withdraw from the contest before it is too late, without any condition or promise, leaving it to the sense of justice and good feeling among the membership of the Institute to rectify matters at a later date.

Mining Law Revision

On another page we publish a vigorous and not altogether courteous protest from Mr. Horace V. Winchell against sundry remarks of ours on the proposed amendment of the mining law. We do not resent the unrestrained vigor of his letter because we happen to be aware that the matter is one that he has much at heart and it is one to which he has devoted much time and talent. Mr. Winchell quotes Mr. W. H. Dickson's opinion of the existing law in order to prove how ignorant we are, but he knows, as well as we do, that more than one lawyer of equal authority could be quoted against a change and in support of the contention that the present law is understood, that is, as well understood as any law dealing with technical conditions of the greatest complexity. It is probable that any new law would have to undergo the baptism of much litigation before its intent would be as clear as that of the one that has now been interpreted by multitudinous decisions. The Latin tag at the end of our learned correspondent's communication pays excessive compliment to the "mind shrouded in the densest ignorance of the subject." We confess that our knowledge of the law and its incidence is much less than that of Mr. Winchell, who has supplemented his experience as a geological witness in the courts with a careful study of the whole subject in its bearing upon the inequities perpetrated in the course of aberrant adjudication, but he is without the one qualification that those less minutely informed may possess, and that is a detached view of this contentious subject. Injustice there has been, of course, but a good deal of justice also; and we have no expectation that any law can be passed that will be unerringly fair, simply because human motives are disregarded by the blind lady with the scales. Our remarks concerning the gentlemen in New York have given umbrage, but is it not proper to insist that they see only one aspect of a many-sided problem and that others equally interested, such as prospectors and mine-operators, are in no way clamorous for the reform that Mr. Winchell and his friends insist upon? Thirty years ago their propaganda would have been timely. At this late date the public mineral domain is a vanishing quantity; the Government cannot withdraw what it has given; a new law would apply successfully only to new districts, while introducing fresh complications into the ownership of claims in the old districts. Here we are reminded of the wearisome law-suit recently concluded in London, between two Rhodesian mining companies, in the course of which the extra-lateral right was involved. Is it not a fact that the extra-lateral right was introduced into the mining law of that new country on the advice of American mining engineers, at least one of whom has been a member of a committee to reform the law in the United States? Leaving this phase of the subject we may mention that a leading member of the Mining and Metallurgical Society has written to ask how the prospector's opportunity may be enlarged and how the idle holding of claims may be discouraged or penalized. These are pertinent queries. The modification of 'discovery' as a preliminary to location might help the prospector, but, as a matter of fact, it has been already excused by tacit consent of the mining community in such districts as Leadville and Tonopah, where outcrops are scarce. The courts protect possession where the claimant is working in good faith, but the informal agreement to disregard this requirement of discovery is no bar to the Government's right of possession in case the law has not been observed. The location of a group of claims without discovery, the protection of possessory rights pending proof of mineral character, and the postponement of patent until ore has been found would operate like the French *permis de recherche,* or permit to explore, previous to selection of a definite and smaller area as the place of systematic mining. Such a regulation, if embodied in statutory form might help the prospector, although the courts already give him the benefit of the doubt. On the other hand, we can suggest no way of compelling work on idle claims, except for the State and County to pile taxes on the owners of them. This is done, in effect, by assessors, who make it harder for the non-resident owner of property than for the resident. The Government cannot deprive the non-operative owner of his patented claim except by condemnation for public utility, for anything else would be contrary to the constitutional inhibition that you shall not deprive a man of his property without due process of law. On the whole, it seems to us that the easing of the 'discovery' requirement before location is about the most practicable reform. It is already a dead letter in a few districts and as laws derive their force from public opinion, this part of the law is quietly ignored in some parts of the country. An enactment relieving the prospector of the obligation to discover mineral where the geologic conditions did not permit a ready disclosure would simplify matters and give him a more reasonable opportunity to extend his activities under legal protection. It would give him the right, with his partners, to hold enough ground long enough to enable him to find ore in place and so qualify his claims for patent. The miner's right to hold locations without discovery should depend upon his doing the requisite assessment work, as now, and showing good faith in the search for ore by sinking or cross-cutting, so as to check more unproductive alienation of the land. We shall be glad to have Mr. Winchell's ideas on the matter.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

The Re-Location Habit

The Editor:

Sir—I read not long since in some paper that California has passed a law which makes it illegal for the owner of an unpatented mining claim on which the annual assessment work has not been done, to re-locate such claim within three years from the date of his failure to perform the required annual work. I consider this a 'bully' law, and one that other States would do well to add to their statutes. It eliminates the 'claim hog' and gives the fellow a chance who is willing to do work on a prospect. I have known of men claiming anywhere from three or four to over a hundred locations in one district and not doing work on more than one or two, and sometimes on none at all. Each year they go around and relocate, talk like a 'bad-man-from-Bodie,' and bluff peaceful men, who are looking for a reasonable prospect and not a gun-fight. In one district I knew an old cuss—a rank bluffer—who did no work, but claimed 160 locations. It would have required annual labor or improvements to the amount of $16,000 and he didn't have $16. It is such men as this who retard the legitimate development of mining districts. I am for the law that demands from claim holders that they do the work required by the law or get out, and give another man who will, a chance.

NIL DESPERANDUM.

Rochford, S. D., December 23.

Mining Law Revision

The Editor:

Sir—In your editorial columns of December 23, I read with some amusement and more impatience the following statement regarding the Federal mining law: "The old law, defective as it may be, has been filtered through the courts until its intent is clear."

The same idea has found expression in several of your recent issues. It is to be presumed that some of your readers are accustomed to place a degree of confidence in the statements in your editorials, and others are likely to quote them as authoritative whether they believe them or not. It is not my intention or desire at this time to enter into an extended discussion of the subject. I wish to make but one criticism of the statement which is quoted above. It is not only untrue but so far from the truth as to be absurd, and can emanate only from a mind shrouded in the densest ignorance of the subject. I make this assertion of my own knowledge, but if further authority is needed I beg to refer you to the statement of Hon. W. H. Dickson of Salt Lake City, perhaps the most experienced mining attorney in the United States (Doc. No. 233, 64th Congress, p. 58): "The statute has now been in force nearly forty-four years and notwithstanding the great multitude of litigated cases that have risen out of it, its true meaning or interpretation is still unsettled as to many questions." And again after referring to several unsettled points, he says: "The foregoing are some of the questions of law yet undetermined. Doubtless there are many others—but if every question as to the true interpretation of the act and its application to any and all conditions to every state of facts which might be established, were finally settled, it would not greatly curtail the volume of litigation arising out of it."

Verbum sat sapienti.

HORACE V. WINCHELL.

Minneapolis, December 28.

[In our last issue we asked for frank criticism; here is some of it, and it is welcome.—EDITOR.]

Pan-Americanism

The Editor:

Sir—Have just finished reading your editorial of November 18, on 'Pan-Americanism—A Myth,' which was received while I was away. As you know, I am very much interested in the South American countries and in our export trade with them, therefore, I believe that while many of the things you stated in your editorial are basicly true, your conclusions are not justified.

The South American countries are farther away from the United States than they are from Europe, but that is no reason why we should not extend our trade with them. Their racial characteristics are more allied to the southern Latin countries of Europe than they are to us, but trade is carried on between South America and Europe, not with the Latin countries, but with Germany and England, which are farther removed in respect to kinship than we are. Commerce does find the cheapest markets and if we are to hold any trade, we must come into competition with the producing countries of Europe. We are able to do this even in Europe itself. Shall we then decline to try and meet that competition in South America, China, and Africa because in the past we have held such a small proportion of the trade with those places? Rather, I should say, we should bend every effort to increase our trade with those countries and had

we done so during the last three years much of that trade would be definitely linked with us and never would return to the channels it had before the War.

That we do produce the things that South America wants is shown by the large amount of business we have done in those countries since the European war cut them off from trading with Europe. But we do not give them as good service as the European countries did because we have not studied and tried to understand their conditions. On my recent trip on the west coast of South America I had the opportunity of meeting many merchants and business men and discussing the question with them. One of them had just received a consignment of paint from a New York house. The paint had not been properly packed, the cases not even being strapped, with the result that not one quarter of the order could be used. This merchant said to me, "We want to trade with the United States but look at the condition in which we receive goods ordered; they tell us we can collect insurance and they will help us, but we don't want the insurance, we need the goods and need them badly." This simply goes to show that we do not understand the arduous handling to which goods are subjected and make no provision for same. The buyers in those countries are willing to pay extra, and glad to do so, for the proper packing and protection of goods.

On the train going up to Bolivia I met several traveling-men from the United States. They could neither speak nor understand Spanish, and yet they were going up to sell goods to people who speak and think only in Spanish. Suppose the average merchant in this country were approached by a traveling-man who could only talk Spanish. He wouldn't even be given a hearing.

As we are an exporting nation and every year are becoming more so, it behooves us to look to all fields. Because Germany sends more goods to the United States than she does to South America, she does not neglect the South American field. So it must be with us. We must study and train a corps of men to introduce our products to South America. We must understand them and do business as they want to do it. Once the average South American gets to do business with houses that he knows and which treat him rightly, he is a confirmed customer and it is a hard thing to get him to change. So with the chance we now have, we should bend every energy to extend and make fast our business relations with our South American relations.

South America produces a great deal that we need, and while it is true that a good part goes to Europe, it is also true that a good part comes back from Europe to us. Why cannot we take these raw products and make them up here and use what we need and export the rest? Of course, there are many adverse conditions to be met but if we are to develop an export trade, we must expect to be in active competition with the rest of the world and I know of no better field that right in South America for trying our powers of competition. We do not have to neglect Europe, or for that matter, the rest of the world in pushing our exports—the whole world is the meeting place of those that are engaged in trade.

Nor should we neglect building up a merchant marine or giving proper protection to the business houses and their representatives who go abroad for new business. We need every encouragement and all possible help to meet competition but I believe we are able and can meet it fairly and squarely.

N. DICKERMAN.

San Francisco, January 2.

Some Pertinent Questions

The Editor:

Sir—How many mine superintendents can correctly answer, off-hand, the following questions:

How many feet of drilling should be done by a miner on an 8-hour shift working with a single-hand hammer?

With a drill of the jack-hammer type?

With a 3¼-inch piston-drill, using 90 lb. of air pressure?

How long a time should a shoveler take to fill a car of 1800 lb. capacity with ordinary quartz ore, or rock, shoveling from the rock floor of a drift?

What is the average cost of shoveling a ton of rock into a car from a rough floor underground when no shoveling-plank or metal sheet is used?

What is the increase of efficiency if a shoveling-floor of plank, or a metal sheet is used?

How far is it safe to carry the face of a drift beyond the last set of timbers?

How far should a trammer push a loaded car on a fair track underground in one minute?

What is the best angle of inclination for a raise that is to be used for the passage of ore or rock?

How many cubic feet of quartz in place are required to weigh one ton?

How many feet, if broken?

How many cubic feet of fresh air per minute should be sent to the face of a drift where two men are at work, where the place is lighted by candles—one for each man?

What number of hours of actual work per shift results in the greatest efficiency of men?

How far apart should loading-chutes be placed on a level to get the greatest economy in handling ore in the stope above?

Is the bonus-system advisable in underground work? If so, why? If not, why?

Is the contract-system in mining work a good one? If so, why?

A. B. C.

Copperopolis, December 9.

THE PUTTY-KNIFE of the glazier is a most convenient and effective implement with which to clean-up amalgam plates. It is flexible and readily removes the accumulated amalgam and is much less likely to scratch the plate than the chisels made from old rasps, so commonly used in cleaning-up in stamp-mills.

THE SHOVEL CREEK DREDGE, SHOWING ANGULAR CHARACTER OF GRAVEL AND THE LIMESTONE BEDROCK.

Dredging for Gold on Seward Peninsula, Alaska—Season 1916

By Corey C. Brayton

Gold dredging on Seward Peninsula is unique. This land area is the most western of the American continent and lies just below the Arctic circle. Gold was discovered at Nome, the chief distributing-point and centre of mining activity, about the time dredging was started at Oroville in California. The first mining, of course, was done by pick and shovel, either on surface or underground, and this method was entirely satisfactory except under unfavorable conditions, such as low gold contents, and difficult or impossible drainage.

It was only natural that miners should soon turn to machinery in order to increase their output. All kinds of mechanical equipment were built and tried, principally on the beach, and along the Snake river, which had several rich tributaries. None of this early machinery, however, was satisfactory. The first successful dredge was built by W. L. Leland, of the Three Friends company, (now the Seward Dredging Co.) on Solomon river. This was a 5-ft. Californian standard machine, steam-driven. It is still operating, but is now using electricity generated by a Diesel plant on shore. Since then the number of successful dredges has increased rapidly, until now there are 34 in operation.

Conditions on Seward Peninsula differ from those in California, or, for that matter, from any other region in the world. Dredging is confined principally to narrow but comparatively rich creek deposits. The areas are small; the depth is shallow, averaging about 8 ft.; the season is only four months, and both labor and power are expensive. Operating costs necessarily are high, but so also is the grade of the gravel.

The chief difficulties are operating during a short cold period before the final freeze-up, and digging gravel too shallow for floating the dredge. The cold is not so serious, but the shallowness of the gravel often involves digging into hard barren bedrock, or the construction of dams, to secure the necessary depth. The building of dams is usual and is neither excessively expensive nor difficult.

The operation of a dredge in shallow ground presents a great many problems that the operator accustomed to deep ground does not have to face. It is like the contrast between shallow and deep-water navigation. The operator accustomed to deep ground has to forget a good many things and adapt himself to new and different conditions.

The Californian type of dredge was not well adapted to the conditions on the Peninsula, though there are places in which it is used. It was necessary to develop a dredge suited to the special conditions. In general the shallow and loose gravel is easily dug and does not require the strength of the Californian machine; moreover, the gold is usually coarse and does not demand the large table area of the Californian dredge. These two conditions, together with the smallness of the alluvial areas, made it advisable to employ a light-weight cheaply constructed machine, and this is the sort of machine in use.

	Name of company	Type of dredge	Builders	Date	Bucket, Cu. Ft.	Line	Power	Number and hp. of engines	Depth, Ft.	Locality
1.	York Dredging Co.	Screen-flume	Union	1911	2½	Open	Distillate, vertical,	2 40	4–7	Grouse Creek, York district
2.	American Tin Dredging Co.	" "	American	1914	2	"	" "	1 80	4	Buck Creek, York district
3.	Max Hirschberg	Flume	"	1913	2	"	" "	1 60	6	Sunset Creek, near Teller
4.	*Bernard	"	"	1914	2	"	" "	1 50	6–10	Anikovik river, York district
5.	*Bernard	"	"	1914	2	"	" "	1 50	6–10	" " " "
6.	J. A. Welsch	Screen	Union	1912	3	"	" " 1 50,	1 40	12	Windy creek, American river
7.	Behring Dredging Co.	Screen-flume	"	1915	2¾	Close	" horizontal,	2 50	7–10	Kougarok river, near Taylor creek
8.	Deering Dredging Co.	Flume	American	1913	2	Open	" vertical,	1 50	7–10	Inmachuck river
9.	Candle Creek Dredging Co.	"	Union	1912	2	"	" horizontal,	1 50	7–10	Candle creek
10.	Iver Johnson	"	"	1913	3½	Close	" "	2 50	12–15	Keewalik river, near Candle creek
11.	Arctic Gold Dredging Co.	Screen	"	1910	2¾	Open	" vert. 1 50, hor.	1 50	25	Hobson creek
12.	Bangor Dredging Co.	"	"	1914	3½	Close	Bolinder, 1 80,	1 60	35–50	Bangor creek
13.	Guinan & Ames	Screen-flume	"	1916	2	Open	Scandia,	1 60	14–17	Glacier creek
14.	Ernst Bros. Dredging Co.	Flume	American-Union	1913	2	"	Distillate, vertical,	1 50	8–12	Nome, on beach
15.	Andy Anderson	Screen	Union	1915	3½	Close	Mietz & Weiss, 1 80, 1 35, 1 12		25	Center creek, at Snake river
16.	Alaska Mines Corporation	"	Smith	1908	7	"	Electric, steam		25–35	Tundra, near Nome
17.	Alaska Mines Corporation	"	Smith-Miles	1917	8½	"	" "		40–60	" " "
18.	Julian Dredging Co.	"	Union	1911	2¾	Open	Distillate, vert., 1 35,	1 50	10–15	Osborn creek, near Nome estuary
19.	Hastings Cr. Gold Dredg. Co.	Flume	"	1909	2¾	"	" "	1 50	6	Hastings creek
20.	*Plein Dredging Co.	Screen	Risdon	1909	3	"	Steam		7–15	Otter creek, near Nome river
21.	Arctic Creek Dredging Co.	Flume	Flume	1914	2½	"	Distillate, horizontal, 1	60	7	Arctic creek, near Penny river
22.	*Shovel Creek Gold Dredg. Co.	Screen	Yuba	1912	2½	Close	" vert., 1 40, 1	80	7	Shovel creek, Solomon district
23.	Seward Dredging Co.	"	West. Engr.	1905	5	"	Electric, Diesel		8–20	Solomon river
24.	Kimball No. 1	Flume	Flume	1911	2½	Open	Distillate, horizontal, 1	60	10	" "
25.	Kimball No. 2	"	"	1914	2½	"	" " 1	60	12	" "
26.	Flowers	Screen	Risdon	1910	2½	"	Scandia		15	" "
27.	*Solomon Dredging Co.	"	Yuba	1910	5	Close	Steam		6–9	" "
28.	*Ruby Dredging Co.	Flume	Union	1912	2¾	Open	Distillate, vert., 1 40, 1	50	4–12	Casa de Paga river
29.	Goose Creek Dredging Co.	"	Jackson I. W.	1909	2½	"	" hor., 1 40, 1	35	6	Goose Creek, near Casa de Paga river
30.	Uplift Mining Co.	Screen-flume	Union	1916	2	"	" " 1	60	10–12	Camp creek, near Niukluk river
31.	Nome Montana Co.	Screen	Risdon	1908	5	"	Steam		15	Solomon river
32.	*Sievertson & Johnson	"	"	1910	2½	"	"		5–8	" "
33.	Moody Mining Syndicate	Flume	Flume	1912	2½	"	Distillate, horizontal, 1	60	6	Canon creek, near Casa de Paga river
34.	*Willow Creek Dredging Co.	Screen	Union I. W.	1911	3½	"	" vertical		6–8	Willow creek, near Casa de Paga river
35.	Oro Mining Co.	Flume	Bernard	1909	1	"	" horizontal, 1	18	5	Elkhorn creek, near Niukluk river
36.	Warm Creek Dredging Co.	"	Jackson I. W.	1909	2½	"	" "		6	Warm creek, Council district
37.	Northern Light Mining Co.	"	Union I. W.	1911	3½	"	" " 2	35	12	Ophir creek, " "
38.	Blue Goose Mining Co.	Screen	Hammond	1904	5	Close	Scandia,	1 120	10–12	" " " "
39.	Wild Goose Min. & Trans. Co.	"	Yuba	1910	5	"	Distillate, vertical,	1 125	10	" " " "
40.	Flume Dredging Co.	Flume	Flume	1910	2½	Open	" horizontal, 1	50	6	Melsing " " "
41.	Flume Dredging Co.	"	"	1913	2½	"	" " 1	60	8	" " " "
42.	Kelliher Dredging Co.	Screen	Risdon	1910	2½	"	" vertical		10–12	Kougarok, above Taylor creek

*Closed down.

BUILDERS

Union—Union Construction Co.
American—American Dredge Building Co.
Risdon—Risdon Iron Works.
Flume—Flume Dredge Co.
Yuba—Yuba Construction Co.
West. Engr.—Western Engineering & Construction Co.
Jackson I. W.—Byron Jackson Iron Works.
Union I. W.—Union Iron Works.

MAP OF THE SEWARD PENINSULA, SHOWING POSITION OF DREDGES.

In California, the first dredges were both too small and too light in construction to suit local conditions. On Seward Peninsula, it was necessary to revert to the lighter type; it was simply a matter of adapting the dredge to existing conditions. The favorite type of dredge in use on the Peninsula is known as the 'flume' dredge. In this machine a flume takes the place of hopper, screen, tables, and stacker. A variation of this type is the combination flume-stacker, which, in addition to the flume, has a short screen with two or three-inch perforations and a flat stacker. To one accustomed to seeing or operating the Californian type of dredge, these small machines look flimsy and inadequate, but, on the contrary, they fit the conditions, and all things considered, are efficient.

With two exceptions, power is obtained from internal-combustion engines on the dredge itself. The fuel consumed by the majority of these power-plants is distillate, but the Diesel and other types of oil-engine are now coming into use. The internal-combustion engine affords expensive but satisfactory power, though in some ways it is not as flexible as an electric motor.

Only narrow, shallow, and unfrozen creek deposits have been dredged up to the present. Deeper deposits of 60 to 70 ft., frozen in places, are now receiving attention, but as yet there is only one dredge operating successfully under these conditions. There has been little dredging of frozen ground on Seward Peninsula. The working of these deep low-grade frozen deposits will be almost entirely a matter of cheap thawing, and that means a thawing method cheaper than those in use on the Yukon.

The adaptation of the gold-dredge to Seward Peninsula has been most interesting and the dredges are, on the whole, satisfactorily designed.

An interesting feature of the development so far has been the part played by men inexperienced in dredging elsewhere, and this was rather fortunate than otherwise, since they were not handicapped by ideas of practice gained elsewhere under quite different conditions.

In numerous cases the dredges built on Seward Peninsula, after having worked out the gravel or for some other reason, have been moved to another locality. In many cases of this kind the machinery is dismantled, the hull cut into two parts, and the moving done on sleds in winter. Moving a dredge in this way is not difficult.

The past season was shorter than usual, the average period of activity over the entire Peninsula having been

two weeks short on account of a late spring. Operations in some cases, however, were carried on unusually late, even into November.

During the season of 1916 two dredges were built.

The total production of gold from Seward Peninsula, as measured by shipments from Nome, amounted to $2,833,000, which was 50,000 more than for the season of 1915. The production from dredges remained about the same.

I have made no attempt to state the yardage handled, the cost of operation, or the fuel consumption. The average daily digging capacity of the 2½-ft. boats on Seward Peninsula is between 700 and 1000 cubic yards. The consumption of distillate is probably $\frac{1}{10}$ to $\frac{1}{8}$ of a gallon per hp.-hour.

The York Dredging Co. finished its ground on Buck creek and is now operating on Grouse creek, into which the former empties. The chief feature of this enterprise is that it mines placer-tin instead of gold, and is, so far as I know, the first adaptation of the placer-dredge to the mining of tin.* The early history of this district is interesting. The miners found that a heavy unknown mineral was choking their sluice-boxes; it was identified by the Geological Survey as cassiterite. It was mined more or less successfully for some time by the ordinary pick-and-shovel and sluice-box method. In 1911 the Union Construction Co. designed and built a dredge for the property. This was strictly pioneering, but the machine has been successful. The dredge has a 2½-ft. open line of buckets, a short screen with 3-inch holes, two flumes and a flat stacker. Each flume is cleaned up in the ordinary way once every 12 hours, the entire feed during this time being diverted to the other flume. The concentrate, in the form of cassiterite, averages 65% tin and varies from fine to lumps of 1½ inch. The concentrate is hauled 14 miles to the beach and is shipped to Singapore for smelting. One hundred and ten tons of concentrate was produced in the three months' season of 1916.

The present depth of dredging is 7 ft., but on Buck creek the usual difficulties of shallow ground were encountered. The dredge has a capacity of about 1000 cu. yd. per day, which is to be increased in the coming season.

The American Tin Dredging Co. operates a dredge of a design similar to the above, constructed by the American Dredge Building & Construction Co., on Buck creek. The dredge operates in 4-ft. ground and has much trouble in securing the depth of water necessary to float the boat.

The Bernard dredge, formerly on Anikovik river, but now dismantled, is interesting for the fact that it has been unsuccessful in both its present site and the one from which it was moved, and also for the fact that it was towed from its old site on the beach, four miles east of Nome, some 100 miles on Bering sea to its present position. This was done without very much difficulty.

The J. A. Welsch dredge, on Windy creek, finished its ground this season, and may possibly be moved to the Kougarok river north of Arizona creek. This dredge in its operation on Windy creek has had considerable trouble with frozen ground.

The Behring Dredging Co. has finished its second season on the Kougarok river near Taylor creek. This is a 2¾-ft. Union screen-flume dredge and has been successful in its operation.

The Iver Johnson, a 3½-ft. flume-dredge built by the Union Construction Co., will move from the Kougarok river to the Kerwalik river during the winter. This dredge has worked out its ground.

The Ernst Alaska Dredging Co. operates a 2-ft. flume-dredge west of Nome, on what is known as the sand-spit. The dredge was towed last summer to its new site, a distance of two miles from its old position on the east side of Nome. It operated on the east side of Nome for four seasons on a narrow flat extending back a short distance from the beach. It has worked up to the water-line and, on several occasions, has been stranded high and dry by the storms of Bering Sea. To a large extent the dredge has handled material worked by hand in the early days. This operation is the only instance of the successful application of machinery to the present beach-sand.

The Andy Anderson dredge is operating on Center creek at its junction with the Snake river. This is a 3½-ft. dredge, and was moved and re-built by the Union Construction Co., in 1915. It is working a stretch of gravel from the old Center Creek intermediate beach-diggings. There are some, but not many, frozen spots that require thawing. This dredge has been successful.

The Bangor Dredging Co. operates the deepest-digging boat on the Peninsula at the present time. This dredge is a 3½-ft. Californian type, built by the Union Construction Co., in 1914. It was built on 35-ft. ground, but designed to take a digging-ladder extension to work to 50 ft. below the water-level, which it has done this last season. The dredge has a capacity of 1600 to 1700 cu. yd. per day. The gravel contains considerable clay, which interferes with washing and diminishes capacity. This dredge has the only installation of Bolinder engines on the Peninsula; they operate on 'calol' (a special product of Californian oil) and have proved a satisfactory source of power. The consumption of fuel is 195 gal. per day. Assuming a 20-hr. day at full 140 hp., the consumption is at the rate of 0.55 lb. per hp.-hour. The company reports an operating cost, exclusive of interest and depreciation, of 9c. per cu. yd., which is as low a cost as has been obtained on the Peninsula.

The Guinan & Ames Dredging Co. operates a 2-ft. combination screen-flume dredge, built on Glacier creek in 1916 by the Union Construction Co. This is a creek that produced abundantly in the old days of hand-mining, the Utica claim having been worked twice. Besides gold, this dredge is reported to have recovered 400 lb. of scheelite concentrate per week. Scheelite on Glacier

*Dredging for tin is being done by five mining companies in the Malay State of Perak and one in Siam.—Editor.

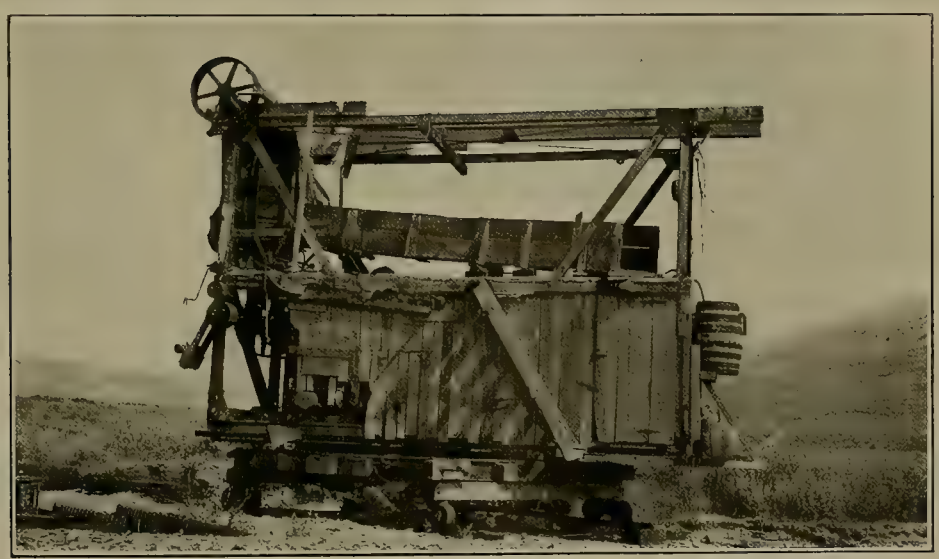
A MODERN ALASKAN DREDGE.

creek caused a good deal of sluice-box trouble during the early days.

The Uplift Mining Co. began operating a new 2-ft. screen-flume dredge built by the Union Construction Co., this year, on Camp creek in the Council district.

The Ruby Dredging Co., on the Casa de Paga, did not operate this season, having worked out its ground, but will probably be moved to a new site next season.

The Alaska Mines Corporation is a re-organization of the E. E. Powell companies, which have operated for a long time near Nome, but not successfully. The old companies have operated the Bourbon and Wonder dredges, the former on Bourbon creek about a mile from Snake river, and the latter on Wonder creek in the vicinity of the Third Beach. The management of the property is now in the hands of J. H. Miles. A new screen, tables, and distributer will be placed on the Bourbon dredge. The new hull, which was constructed several seasons ago, but which has never had its machinery on board, will receive the 8½-ft. bucket-line and equipment from the Yuba Consolidated Gold Fields dredge No. 6. The steam-turbine power-plant owned by the company and furnishing electricity for the boats, will be thoroughly overhauled, and a good deal of drilling will be done. Thawing experiments will be conducted to demonstrate the best and cheapest method. The old Wonder dredge will be scrapped. It is planned to have everything in operation by July 15. These dredges are in what is called the 'tundra' country between Nome and the Third Beach, and the ground varies



A PIONEER DREDGE, NOW DISCARDED. THE BUCKET-LINE HAS BEEN REMOVED.

from 25 to 60 ft. in depth. It is frozen in spots and the old dredges at times attempted to dig without thawing, which was, of course, unsuccessful.

The Seward Dredging Co. (formerly the Three Friends Dredging Co.) operates a 5-ft. Californian dredge on Solomon river. This was the first dredge to be operated profitably on the Peninsula, being built in 1905 by W. L. Leland. Recently the company has had a rather checkered career but has continued to operate. In 1914 W. H. Estabrook had a bond-lease on the property and replaced the old steam-plant on the dredge with motors and installed a Diesel generating-plant on the shore. The steam-plant power-cost has always been excessive. The Diesel plant, with the exception of some compressor troubles at the start, has proved satisfactory. The cost of power is 1¼c. per kw.-hr. when the dredge is digging 3000 cu. yd. per day. Fuel (equal to 'calol') consumption is approximately 0.45 lb. per hp.-hour. The dredge was not well-adapted to the shallow ground and for other reasons it has never had a high capacity. In 1914, under the superintendence of J. H. Miles, for W. H. Estabrook, the dredge had a capacity of 3000 cu. yd. per day, but I believe that this capacity has not been maintained. During the last two seasons the ground has been exceptionally rich.

The Kimball dredge No. 1, constructed by the Flume Dredge Co., was moved during this last winter from Shovel creek to Solomon river. This dredge operated almost five full seasons on Shovel creek and was successful. The new site is on ground previously worked by the original Sievertson dredge, a small oddly-designed machine built for working on the Nome beach in 1900, and later moved to several positions on the Solomon river. The Kimball No. 1 dredge was the first successful flume-type of machine in the Solomon district and did excellent work under severe conditions on Shovel creek.

The Kimball dredge No. 2 is working on the Solomon river close to No. 1 on the Gypsy bench some feet higher than the present river. Water is led to the pond by means of a ditch. This is the third season for this dredge.

The Flowers dredge, formerly operated by C. Flodin, on Solomon river near Big Hurrah, is to be moved this winter to a new site on Solomon river, a short distance below Oro Fino. This is a Risdon dredge with 2½-ft. buckets and was originally operated by steam-power. Scandia engines, in all probability, will replace steam in the future.

The Goose Creek dredge, operating on Goose creek, a tributary of the Casa de Paga, changed ownership last spring. This was originally a screen-dredge and was changed to the flume type when it was moved to this site two years ago.

The Nome Montana Dredging Co. has not been operating for the past two seasons. It is reported that this boat will be moved to a new position on the lower Solomon river.

The Moody Mining Syndicate is operating a flume-dredge formerly owned by C. Flodin on Canon creek, a tributary of the Casa de Paga. The hull was cut into two parts to facilitate moving.

The Oro Mining Co. has an interesting equipment on Elkhorn creek, a tributary of the Casa de Paga—interesting from the fact that it is the smallest dredge operating on Seward Peninsula, and during the last season, in proportion to its size, has been the most successful. It has a bucket of 1 cu. ft. capacity and is operated by one 18-hp. distillate-engine. The conditions are ideal for this type of machine.

The Warm Creek Dredging Co. was originally a screen-dredge and not long ago it was changed to the flume type.

The Northern Light Mining Co. last winter moved its dredge, formerly operated by Lubbe on Mystery creek, to the lower end of Ophir creek.

The Blue Goose Mining Co. operates a dredge first constructed in 1904. The buckets dump into a flume 20 ft. long that dumps into a screen. In other respects the dredge is of the standard screen-type. It has been reconstructed once or twice, and until this last season has operated on steam, with wood for fuel. During the last season a 120-hp. Scandia engine was used, but not with complete satisfaction. This company has always had high-grade ground and has done unusually well.

The Wild Goose Mining & Trading Co. operates a standard Californian dredge on Upper Ophir creek. The power is supplied by a distillate-engine. It is reported that the company will provide a hydro-electric plant, taking the water formerly used for hydraulic elevators. This ground is also high-grade and the company has done well.

The Flume Dredge Co. No. 1 dredge is at present operating on Melsing creek. It holds the record, I believe, for the number of moves. It was originally built on Melsing creek in 1910. The hull was cut in two and the dredge moved to Ophir creek. The next move was from Ophir creek to Crooked creek, but in this case the dredge dug its own way. The final move was back again to Melsing creek, but the hull was not moved, since the distance and the price of timber made it inadvisable. This dredge really marked the beginning of the flume-type of dredge on the Peninsula.

The following companies, which with one exception have been operating for several years, worked through the season as usual.

Max Hirschberg, Sunset creek, north of Teller.

The Deering Dredging Co., Inmachuck river.

Hank Fries, on the Inmachuck river.

Candle Creek Dredging Co., on Candle creek.

Arctic Gold Dredging Co., Frank Middaugh, manager, on Hobson creek.

Julian Dredging Co., E. A. Julian, manager, on Osborne creek.

Hastings Creek Gold Dredging Co., now operating a dredge on Hastings creek, formerly operated on Moss gulch.

Flume Dredge Co., No. 2, on Melsing creek.

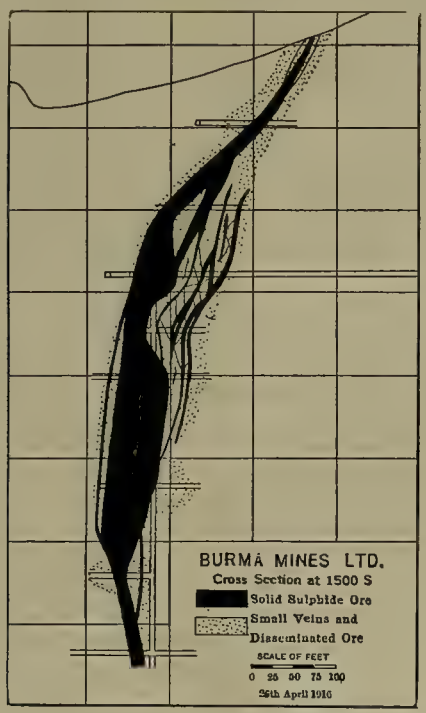
Arctic Creek Dredging Co., on Arctic creek, Nome.

Geology of the Bawdwin Mines

By M. H. Loveman

Introduction. *Bawdwin is in the State of Tawng Peng, one of the units that constitute the Northern Shan States. It is under British rule and is generally considered as part of Burma.

The orebodies here described have been re-discovered and developed within the last three years. When mining first began at Bawdwin is not known, but it must have been as early as the beginning of the 15th century, as indicated by Chinese inscriptions. The mines were abandoned by the Chinese about 1868, probably because of the great increase in the volume of water appearing in the workings. During the long occupation of the Chinese they performed an immense amount of work, having removed more than 1,000,000 tons of rock. The attention of Europeans was first directed to the mines by the big slag-dumps. When the slag was removed, work was commenced on the orebodies, but as the old workings were filled with water the progress made at first was slow and dangerous.



General Geology. The rocks of Tawng Peng are all of the pre-Cambrian and Paleozoic eras. The west and central portions of the State are mainly composed of mica-schist, and of much-folded unfossiliferous shale and quartzite. There are also extensive granitic intrusions of undetermined age. The metamorphic rocks are followed unconformably by Ordovician sediments, and the schist is therefore either Cambrian or pre-Cambrian. Silurian sandstone, in places, is found resting directly upon the unfossiliferous series. At a few places along the border of the pre-Ordovician rocks are small exposures of rhyolite, tuff, breccia, and flows. The most important of these is the rhyolite at Bawdwin.

In the vicinity of the mine are narrow valleys amid precipitous hills, which rise more than 2000 ft. above the valley-floor. The hills are destitute of timber, the trees having been removed years ago for fuel, and 50 years of idleness has not resulted in re-forestation.

The rocks at Bawdwin are first, the rhyolite tuff, breccia and flows; second, the overlying and underlying non-fossiliferous sedimentaries. No limestone has been found in the sediments. The sandstone is red to gray, with small irregular quartz grains cemented by sericite.

*Abstract Trans. A. I. M. E., New York meeting, February 1917.

The shale is light-gray to purplish in color and is compact, the original laminations being almost wholly destroyed.

The rhyolite forms a northwest-southeast band of irregular outline with many offshoots, some of which are connected directly with the main mass, and in some instances disconnected, occurring as separate outcrops in the sediments. The general outcrop of the rhyolite indicates the axis of the anticline, which plunges both north and south. This anticline is the principal one of a series of folds that parallel the rhyolite. Almost the entire exposure of the rhyolite is tuffaceous, with local areas where it includes numerous fragments constituting a breccia. Away from the zone of mineralization the rhyolite is a hard dense rock, with many phenocrysts of quartz and feldspar. These sometimes, particularly in the case of the feldspar, attain dimensions of an inch or more. Where alteration has been pronounced the feldspar has changed to sericite, though in the orebody the alteration is more complete, and the feldspars are largely metamorphosed to kaolin. Generally the outline of the crystals has been obliterated. There are occasional traces of a ferro-magnesian mineral, probably amphibole. Zircon, apatite, and tourmaline are present in small amount. The rock of the ore-channel has been entirely transformed by crushing, leaching, and silicification.

The Ore-Zone. The orebodies occur in a zone 300 to 1000 ft. wide in the rhyolite-tuff. The boundary of the zone is not sharply defined, mineralization near the borders gradually becoming less until it ceases entirely. In the south-western part of the rhyolitic area the tuffaceous character of the rock is more pronounced, and it is through this that the zone of mineralization extends, passing beyond into the harder finer-textured rhyolite that makes up the greater part of the rhyolitic area, though in this harder rock mineralization is much less pronounced.

The rock of the ore-zone varies from fine-textured silicified tuff to a rock composed chiefly of the included fragments of other rocks. Large kaolinized feldspars are characteristic of the big orebodies. The principal feature appears to be a silicification that has replaced practically all of the original constituents of the rock. In the ore-channel the rock is a mixture of quartz, sericite, chlorite, and kaolin, with some calcite.

The Orebodies. The valuable metals are zinc, as sphalerite; lead, as galena; copper, as chalcopyrite; and silver, the manner of occurrence of which has not been determined, though it appears to be directly associated with the galena. The ore occurs in solid sulphide masses with but little gangue; as veins; as reticulated seams, forming a stockwork; and as an impregnation of the rock-mass. The principal orebody, called the Chinaman Lode, is 1200 ft. long, and from a few feet to more than 100 ft. wide. It is a zinc-lead-silver orebody, with a small quantity of copper along the edges. The largest single body of copper ore is found on the 300-ft. level, north of the Chinaman Lode. It is 130 ft. long with an average width of 30 ft., running 14% copper, 7 oz. silver, and a small percentage of lead and zinc on that level. About 75 ft. higher it passes into zinc-lead ore, and does the same 30 ft. below the 300-ft. level. This orebody is thought to be the northern extension of the Chinaman Lode, beyond its interruption by a fault.

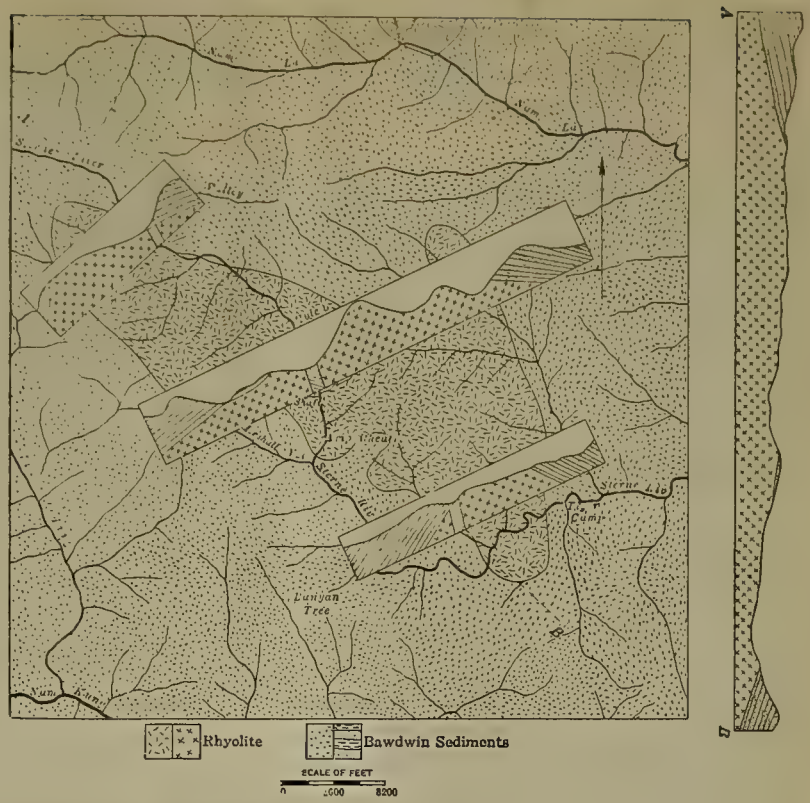
A cross-section through the Chinaman Lode shows a central core of solid zinc-lead sulphide, the zinc generally predominating. On both sides of this central core are alternating bands of heavily mineralized tuff and solid ore. These, in a general way, parallel the central portion in both strike and dip, but they pinch out, coalesce, and are otherwise irregular. The bands are higher in lead than in zinc. Usually copper is found along the edges, and occasional seams and bunches of ore are found at some distance from the main orebody. Pyrite is found to a limited extent in the main orebody, but in greater amount near the edges. The central core of the Chinaman Lode is solid ore as much as 80 ft. thick; on some levels it maintains an average width of 55 ft. for 800 ft. in length, and of 50 ft. for an additional 200 ft. One block, 800 ft. long, 600 ft. high, and 30 ft. wide contains 1,750,000 tons of ore, with an average of 30 oz. silver per ton, 31% lead, and 29% zinc. This block is over 75% solid sulphides of lead and zinc. The mass has a high west dip in the upper levels, turning over gradually with increasing depth, until it dips steeply eastward. It thins out gradually on approaching the sedimentary rock.

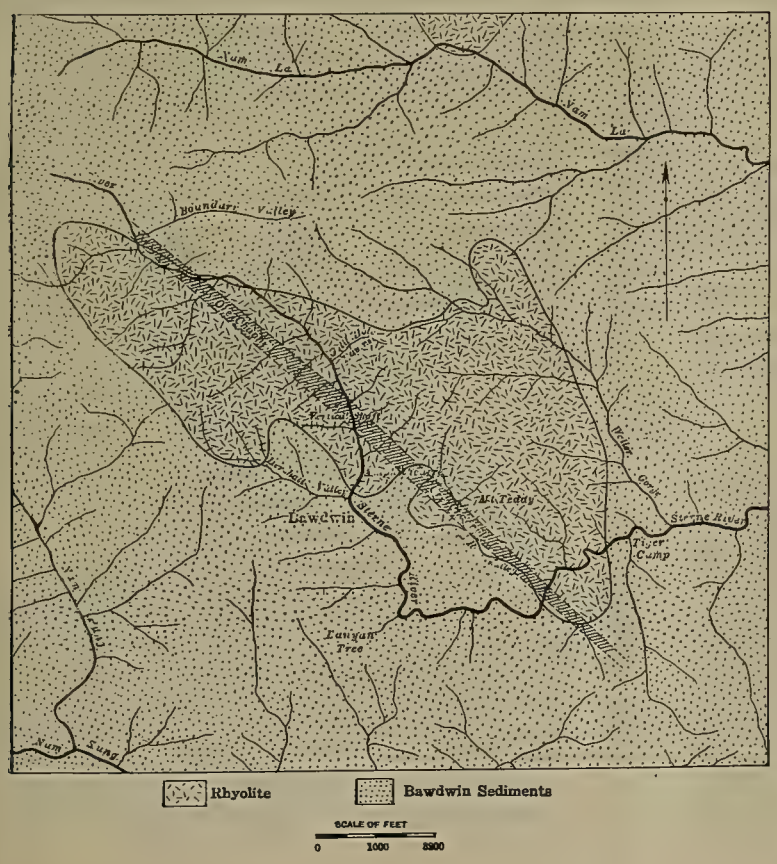
Owing to the work done by the early miners, the condition and shape of the orebody near the top is concealed, but it appears to thin out in the approach to surface. The outcrop is comparatively small and inconspicuous. At several places sphalerite and galena are found in the outcrop, but generally the surficial ore has been oxidized and leached, the outcrop being indicated by a broad zone of soft decomposed rock colored by iron oxide, copper carbonate, and lead ore. This gossan runs 3 to 4 oz. silver and 5% lead per ton. It is quarried at one place for silicious flux. The depth of the gossan varies from place to place, but is rarely more than 50 ft. It is succeeded generally by a zone carrying secondary copper sulphide, principally chalcocite with some bornite. Where the zinc and lead sulphides appear at the surface it continues to the greatest depth thus far reached in the mine, 725 ft., with no change in character. The lead-zinc ore is an intimate mixture of galena and sphalerite, the galena forming around grains of sphalerite, and as thin filaments through the blende. The ore grades off in both directions—toward the zinc end to a solid mass of soft sphalerite, and toward the lead end to pure coarsely-cubical galena.

The silver content varies with that of the lead and independent of the zinc, indicating that the silver is associated with the lead. The presence of copper, even in small amount, destroys the silver-lead ratio, as the copper in the small veins adjoining the main orebody is often high in silver. Ordinarily one ounce of silver accompanies 1% of lead.

The Faulting with which the mineralization is associated was not confined to a single plane, but occupies a zone in places 1000 ft. wide. Along this zone a multitude of fractures of varying strike and dip were developed. As a system it is complicated, and a majority of the faults can be traced a short distance only. The displacement in most instances has been slight, often scarcely noticeable. However, a few dominant faults that can be traced a long way have been accompanied by considerable displacement. One such fault cuts off the Chinaman orebody at its southern end, for beyond it no ore has been discovered.

The faults, as a rule, are accompanied by soft gouge and rounded fragments of rock. The gouge is often colored black by minute particles of sulphide. Generally the faults appear to be later than the mineralization, and it is probable that some of the orebodies branching off from the main Chinaman





Lode may lie along fault-planes. In the big orebody the complete replacement of rock by sulphide has obliterated the original character of the ground, so that the ore now represents a replacement of the original rock in a widely fractured and crushed zone rather than one that has spread out into the walls from a central fault-plane.

The Ground-Water level is close to the surface. The ore-channel strikes diagonally across the trend of the ridges, so that the ground-water was tapped by the drainage adits only a few feet from the valley-bottoms. There did not, however, appear to be a saturated zone below the water-level. Diamond-drill holes at a greater depth than any of the workings occasionally go completely dry, and water pumped into them disappears. This experience was noted even in cases where the holes were cemented all the way down. The great number of old workings and the numerous fault-planes tend to obscure the natural underground circulation. A heavy rainfall has an almost immediate effect on the amount of water in

the upper levels, and a portion of the surface-water probably drains along faults to the lowest levels.

It does not appear that changes of great magnitude have occurred in the condition of the orebodies since their original formation. There is no distinct zone of secondary enrichment—barring the small amounts of chalcocite—as is indicated by the silver content, which shows no marked change from the upper part of the orebodies to the lowest openings, several hundred feet below the water-level. There is a gradual increase of silver in descending, but this is due to a corresponding increase in lead. The zinc also increases slightly, but this may be attributed to the almost entire disappearance of gangue-minerals and of low-grade patches in the solid core.

Using a Fumerole to Get Steam

An ingenious Italian civil engineer has been successful in employing the heat of a fumerole near Volterra, in Tuscany, to develop 15,000 horse-power. In that district are numerous fissures in the ground from which a large and constant volume of steam escapes violently into the air. The steam contains several minerals in solution, of which boric acid is the most valuable, and this is saved and utilized in the manufacture of borax. The heat of these steam-vents has long been used in warming the dwellings near-by, but until recently only a small part of the steam available has been utilized. In 1903 the first attempt was made to employ the heat of the steam-vents as a source of power. A strong jet of the escaping steam was applied to a small rotary-motor, and this experiment resulting in some success, the steam was conducted to a small reciprocating-engine that was used to run a dynamo, generating enough electricity to light a part of the borax works. These applications proving satisfactory, an effort was made to make available a larger volume of steam by boring holes in the ground. These bore-holes were driven to a depth of from 300 to 500 ft. and were lined with iron pipe. The holes are from 12 to 20 in. diam. The steam issues under a pressure varying from 30 to 150 lb. per square inch, and the temperature is said to range from 300° to 375°F. For years the steam-jets have not diminished their activity, nor is there any decrease in the volume of steam or the pressure when additional holes are bored so long as they are not less than 50 ft. apart. It has been demonstrated that each hole will supply steam at a temperature of 300°F. with the equivalent of 1000 to 2000 theoretical horse-power per hour. The result of the early experiments has been followed up, and in 1906 the steam was applied to a 40-hp. engine with satisfactory results, as far as the generation of power was concerned, but the minerals in solution and the sulphuric acid in the steam had such a corrosive effect on the cylinder of the engine that frequent repairs were necessary. The introduction of the steam directly to the engine was discontinued and it was transferred to the boiler, using the heat of the steam, instead of fuel in the usual way, to raise the temperature of the water in the boiler, and producing a pressure in the boiler of about 30 lb. per sq. in. This boiler-steam was then passed through a super-heater and used to drive a 300-hp. condensing steam-turbine direct-connected to a three-phase generator, which supplied power and light to the works, and to the neighboring villages. This installation was so satisfactory that when coal became scarce and very expensive soon after the beginning of the War, the possibility of employing the steam-vents on a still larger scale was considered seriously. Three sets of condensing turbo-alternators were put in place, each of 3000 kw., operated with super-heated steam at 22½ lb. pressure that was generated in specially constructed tubular boilers of the marine type, and provided with aluminum tubes to resist the corrosive action of the acid. The steam used in driving the turbines is generated from water fed into the boilers, heat being supplied by steam from the vents. The boiler-steam is passed through aluminum pipes arranged between the boilers and the turbines. On its way the temperature is raised to about 300°F. by superheated steam from the vents. The condensed steam from the turbines is returned to the boilers, and no natural steam comes in contact with the engines, thus obviating the corrosion of metal that had been the principal difficulty to overcome.

The success of this novel utilization of a natural source of heat and power suggests the possibility of its application in other regions where similar conditions exist. In California, near Mount Lassen, are numerous fumeroles and steam-vents, particularly in Hot Spring valley, and some application of the energy going to waste there possibly might be made in a manner similar to that adopted in Italy. On the Darragh ranch in Big Smoky valley, Nye county, Nevada, there is a large boiling spring, the temperature of which is stated to be 242°F., or 30° hotter than boiling water. Obviously, it is a possible source of power, but the water is utilized only by directing the stream into a cemented basin in a bath-house. Steamboat Springs, Nevada, near Carson City, is another noted fumerole, but no use whatever has been made of this possible source of power. At Ouray, Colorado, are hot springs, the water of which is used in bath-houses and in a few instances to warm dwellings, yet the heat from this highly heated water is sufficient to give a comfortable temperature when desired to every house in the town. It is merely one of many instances of neglect to take advantage of natural resources.

Magnesite analysis is always stated in terms of magnesia (magnesium oxide), carbon di-oxide, and such impurities as may be present, for example, silica, iron oxide, calcium oxide, and aluminum oxide. The magnesium, as metal, is never given in the usual certificate of analysis of magnesite. Magnesia, also known as periclase, is the natural oxide of magnesium, and consists of magnesium 60%, oxygen 40%. The mineral usually is found in small disseminated grains in some limestone and occasionally with deposits of magnesite.

Design and Operation of Motor Trucks

*At first the design of the motor truck followed closely that of the pleasure-car. This was a natural sequence for a business growing up as a branch of pleasure-car manufacturing. The same type of engine was used for both and the same drive through a differential on a live rear-axle, such as is still in use for trucks of the light-delivery type. For the heavier trucks the frame of the car was lengthened, and the differential and rear-axle gave way to a differential and jackshaft attached to the frame. The jackshaft carried sprockets, and the final drive was made by a chain to the rear wheels, which were carried on a dead axle. This arrangement had three obvious advantages: first, it kept the engine-drive as small and light as possible, since the final reduction in rotations was made at the rear wheels; second, it was accessible, and the gear-ratio could be changed at will by putting a different-size sprocket on the jackshaft; lastly, it segregated the power-plant so that the truck might be considered as composed of two separate units. The first of these units, the wheels, axles and steering-gear, was expected to take the jar and distortion of running, while the other unit, the truck-frame and power-plant, floated above the first one on the springs, the chain furnishing the power connection between the two units. Automobile engineers state that each pound of 'unsprung' weight is as hard on the tires, and therefore on the truck, as four pounds would be if placed above the springs, where the effects of the weight are cushioned. The chain-drive kept the weight of the parts a minimum, and also kept it above the springs.

It was soon discovered that it was not possible to absorb all of the vibration and twisting which hard service gives to a truck without transmitting a considerable part to the frame and power-plant. To the jar from the road was also added the twistings set up in the frame because of eccentric loading. These effects were all transmitted to the power-plant, to the radiator, and to all parts which were attached rigidly to the frame. There were two possible ways of dealing with this difficulty; first, a more rigid frame and a better cushioning through the tires and springs; or, second, a flexible frame to which the various power-plant units would be flexibly mounted, so that each unit, while in itself a compact, rigid, perfectly aligned machine, would not suffer distortion by twisting set up in the frame. These units would be connected by shafts having universal joints or some other flexible connection. The modern truck has been developed along both of these lines. For the lighter and faster-running delivery truck the pneumatic tire is largely used, and its use is being extended to heavier trucks. Double pneumatic tires for the rear wheels are used sometimes, and single tires are being made up to 12 in. tread diameter. Both pneumatic and solid tires have been made as elastic as possible without too great a sacrifice of other desirable qualities. Truck springs have been greatly improved also. The older types of truck springs were made up of rather thick leaves. They were short and narrow and had considerable camber. With the advent of modern heat-treated steel a much better design of spring with thinner leaves has been developed. It is longer, flatter, and better suited to the needs of the truck. Such springs are made of high-grade carbon or alloy steel, with the leaves self-lubricated and the spring-eyes provided with phosphor-bronze bushings. The pins are nickel steel and the clips are chrome-nickel or vanadium steel. The old-fashioned full-elliptical type has given place to the semi-elliptical as the preferred type. This improvement in the design and quality of springs and tires has reduced considerably the strains in the frame.

In the smaller trucks, up to about two tons capacity, it is possible to combine the engine, the flywheel and its clutch, and the transmission in one rigid assembly. This gives perfect alignment. This unit power-plant is then flexibly mounted within the main frame, usually with three points of support, two attached rigidly to the main frame and the third swiveled from a bearing on a main-frame cross-member. Another method is to mount the power-plant rigidly to a sub-frame, which, in turn, is flexibly mounted within the main frame. This mounting may be a three-point support or one of four points, with spring-buffers to absorb the jar and twist. Where the transmission is separate from the engine it is also flexibly mounted to the frame. The differential and jackshaft-unit is treated the same way.

Motor-Truck Engines. Motor-truck engines do not differ greatly from those on pleasure-cars. Motor-truck service is more severe and the engines are kept at capacity for longer times. For this reason the engines are run at slower speeds, from 800 to 1200 r.p.m. for trucks of one ton capacity or heavier, and the engines are therefore larger for the same horse-power. In general, truck-engines are usually built stockier, with heavier crankshafts and connecting rods and larger bearings throughout. The water-jacket space is somewhat larger and the cylinder-walls thicker, which permits more re-boring. The radiator is larger than for the same size of pleasure-car engine. The valves, carburetor, and intake-manifold are often made smaller than on a pleasure car. This is possible with the slower speed, and has the advantage of preventing the driver

*Abstract of paper presented at a meeting of the Los Angeles Section of the American Society of Mechanical Engineers, by W. H. Clapp.

from over-speeding the engine when it is not under governor control. Governors are now coming into general use, however, on trucks of one ton capacity or heavier. The governor throttles the gas mixture between the carburetor and the intake-manifold. It may be driven from any exposed rotating part of the engine, or from the transmission, or from the wheel of the truck itself. The four-cylinder, four-stroke-cycle engine is now standard for truck construction and is used on 95% of the trucks manufactured. There are a few makes of two-cylinder engines with the cylinders opposed to each other. One or two builders have recently brought out six-cylinder engines, but their use for most work would not seem to be warranted at the present price of motor fuel. The four-stroke cycle is made necessary by the varying load which every truck engine must handle.

Cylinders are cast separate, in pairs, or *en bloc*. The preference seems to be for cylinders in pairs with either three or five crankshaft bearings for trucks of moderate to large size, and cylinders *en bloc* with three bearings for the smaller sizes. Individual cylinders are used on many of the larger trucks. As to the placing of valves in the cylinder, the same types obtain as on pleasure-cars. There is a preference for the 'L-head' type for the smaller engines up to about four inches in diameter, as ample valves may be used and still provide for the necessary water-cooling space around them. Nearly 80% of all engines are of this type. With increase of cylinder diameter, cooling is more difficult, and many makers prefer the 'T-head' construction with valves on opposite sides of the cylinder. There are a few motors with the valves in the head, and some with one set of valves in the head and the other in the side. The bore-stroke ratio varies from 1:1.1 up to 1:1.5. Average sizes vary from $3\frac{1}{2}$ by $4\frac{3}{4}$ in. for a 1-ton truck up to 5 by 6 in. for a $7\frac{1}{2}$-ton machine.

The clutch is usually housed with the fly-wheel. The cone-clutch with leather against metal and the cone a part of the fly-wheel itself has been the favorite until recently. The more complex multiple-disk clutches with steel against steel or against bronze plates running in an oil bath, or steel against a built-up fabric of brass wire and asbestos running either in oil or running dry are also largely used. The dry type has been gaining in favor. It is accessible and there is abundant surface to take care of starting-friction.

Transmission System. There are a few friction-type or planetary-type transmissions on some of the lighter trucks, but the selective type with sliding gears, three speeds forward and a reverse, is generally used. It has not been entirely successful for heavy truck duty. The operation of a transmission requires a certain amount of skill and respect for machinery not always found in an unskilled employee. There has been a marked tendency to adopt some form of individual clutch system for the heavier trucks. Also a fourth speed forward on these trucks is coming into use to meet the requirements of tractor duty and of starting under heavy load.

There are two methods of water cooling used on light-truck engines, one the thermo-syphon, for which the claim is made that it is simple and effective, while opposed to the cheaper and simpler method is that of pump circulation, which tends to keep the engine cylinder more nearly uniform in temperature under all running conditions. Other examples of different design for truck parts are the frame members, which may be built-up shapes of channels or I-beams, or pressed-steel frames, which are lighter and more flexible, made of a higher grade of heat-treated steel, more expensive, but coming into increased favor with truck manufacturers. Again, the truck wheels may be of the wooden artillery-type, of cast-steel, or of built-up pressed-steel construction. For bearings, flexible rollers and balls compete with the truncated cone-roller. Brakes are either shoe or band, each of which may be either internally expanding or externally contracting. They may be placed both on the rear wheels, or one set, usually the service brakes, on the jackshaft on chain-drive machines or on the main shaft back of the transmission on the other types of drives. Again, there are four types of radiator construction, twenty standard types of carburetor, and nearly as many ignition systems. Lubrication may be by splash, by forced feed, or a combination of both, and so with nearly every feature of truck construction.

Types of Final Drive. For light-running trucks the pleasure-car type of drive with the differential on the rear axle is customary. Its use is restricted to cars of 1500-lb. capacity or less, as a greater gear-reduction than about five to one gives such a large differential assembly that there is not enough road clearance. An additional speed-reduction of some kind must be made for the heavier trucks. The many advantages of the chain drive have not been sufficient to overcome the objectionable features of exposed grit-collecting parts and broken chains. Three separate types have been developed to meet these objections.

The first of these types, the double-reduction axle, uses one pair of bevel-gears and one pair of spur-gears trained together and housed with the differential on the rear axle. There is the advantage of enclosure of all working parts, quiet operation and no thrust loads on the differential. The assembly is heavy and there are a good many parts. Its use is now restricted to a few makes of light trucks of $1\frac{1}{2}$ tons capacity or less.

The internal-gear drive is also a double-reduction drive, as two sets of gears are used. It is also like the chain drive, in that a dead axle carries the load while the differential is on a jackshaft, but in this drive the jackshaft is carried alongside of and parallel to the rear axle, while the chain connection gives way to a spur-pinion running inside an annular gear on the rear wheels. It is quiet in operation and the parts are all enclosed. It has the advantage of a dead axle to carry the load, an argument that appeals to many customers;

also the differential is smaller than that on the double-reduction drive, as it runs faster. There is, however, a thrust on the differential from the driving shaft. The weight-carrying axle is usually of I-beam construction, and the jackshaft may lie either in front of or back of this axle. This drive was first developed in Europe, and has been used increasingly in this country, principally for trucks of from 1½ to 3 tons capacity.

The worm-gear drive, while it has met with much opposition, is the simplest and possibly the most satisfactory of the three types. It has fewer parts, since the differential is carried within the worm-wheel and the entire reduction is made in one step. There is a live rear axle which transmits the power to the rear wheels. This is usually of the full floating type, with the truck weight carried on the outside of the axle casing. The live axle must be large, as must also be the differential, since there is no reduction in rotations at the wheel. There is a heavy pressure between the worm and wheel, as the wheel is of small diameter. It is necessary to maintain exact alignment between the worm and wheel. This requires a heavy built-up housing to carry the assembly. This housing is of cast construction. All of this weight comes on the tires with no spring intervening. In spite of these objections, the worm drive is now being used on all sizes of trucks from ½ up to 6 tons capacity. The success of the worm drive depends upon exact proportions, perfect alignment at all times, and, most important of all, the maintenance of an oil film which will not be squeezed out by the thrust of the worm-shaft.

There are a variety of four-wheel drives on the market in which various combinations of internal gears or live axles are used to propel the truck through all four wheels. As the front wheels must swivel, and in some cases the rear wheels also are used in steering, it is necessary to provide for this in the drive either by knuckle-joints or through a bevel-gear train with one gear mounted on the swiveling axis. These trucks are much used where the road conditions are severe, as for ore-hauling work in mountainous country or out on the desert, and for army-transport work.

What has been said of the methods of driving gasoline-trucks applies also to battery-driven electric trucks. These trucks, because of their simplicity and durability, and because of a high starting-torque compared with the gasoline truck, are much used for work within their special fields. They are specially suited for delivery service in congested districts and where the number of stops per mile is large, and for special service such as street-work hauling with heavy loads and many stops, drawing conduit wires, raising telephone poles, and wholesale delivery. Their use within these fields would be increased if the first cost were not so high. It is considerably more for the lighter types of truck. Electric trucks are handicapped by a slower speed, about 60% of that of a gasoline truck, and the mileage is limited to between 35 and 45 miles per day as compared with 75 miles or more for the latter. Also, the electric truck must be brought to a point where direct current is available for charging the batteries. For work for which they are suited, the electric trucks will usually show a lower daily cost than gasoline trucks, where the latter are held down to the same number of miles a day. It frequently happens that it is not possible to get a greater mileage with the gasoline truck because of frequent stops and congested streets. The electric truck, with fewer parts, and none of these reciprocating, gives a lower maintenance cost outside of batteries, and the depreciation has been less than on the older types of gasoline trucks.

There is another type of truck which combines both the gasoline-engine and the electric-motor drive. The engine runs at a constant speed at all times, and is direct-connected to a generator which drives motors placed within the four built-up steel wheels of the truck. Each motor is carried by a steering knuckle, and the armature has a pinion at one end which engages with a ring gear on one side of the wheel, while a pinion on the opposite end of the armature engages with another gear on the opposite face of the wheel. This arrangement, while undoubtedly less efficient than the direct-connected drive, has all of the simplicity of the electric truck, for it eliminates all chains, sprockets, clutches, sliding gears and differential. The mileage is unlimited, and it promises to meet the requirements of heavy duty and long-drawn-out service.

For every truck it is necessary to provide some means of resisting the rear-axle torque, which reacts on the driving gear and axle casing. The reduction gear on the rear axle tends to rotate instead of turning the wheel, and carries the axle casing with it. This turning must be prevented by some member connecting the casing with the main frame of the truck. Again, the thrust of the wheels against the roadbed must be made to react on the frame of the truck instead of upon the axle bearings alone, for the frame is suspended on the springs above the axles. There are several ways of taking care of these two forces. The torque may be taken through the rear springs or through separate torque-rods swiveled from the rear-axle housing to the frame. The thrust may be transmitted through the rear springs, or through radius-rods, and these rods may take both thrust and torque, or there may be separate rods for each duty. Where the springs take the thrust they are shackled at the rear end only, and the front end is pin-connected direct to the frame. A combined torque and radius-rod is frequently used for the internal-gear drive axle, and for many of the smaller worm-drive trucks. The larger worm-drive trucks use separate torque and thrust-rods.

The demand for a light truck has been met by making a vehicle which is much lighter for the rated load than the heavier trucks. This is possible because of the higher engine-speed, a more simple final drive, torque and thrust taken through the vehicle springs, and by the generous use of special alloys and heat-treated steels. These trucks are too light for the load

that they are rated to carry as is shown by records, which show that the average life of a light delivery-truck is 35,000 miles, whereas the heavier trucks when properly driven and maintained can be depended upon to give 80,000 to 100,000 miles, or even more for the better grade of trucks. It would seem that there is a real field for a serviceable light truck which will at a little greater cost give enough lower depreciation and maintenance to be a profitable investment.

In California, distillate is being used to quite an extent as a substitute for gasoline. The cost per gallon is about half that of gasoline at the present time, and the B.t.u. content somewhat greater. A local truck-manufacturer has been very successful in equipping trucks with gasifiers by which the heat of the exhaust gases from the engine is used to heat the inlet air as it goes to the carburetor, and also to heat the mixture as it goes from the carburetor to the cylinder. A supply of gasoline is carried and used in starting. The consumption of distillate is about the same as that of gasoline. The success which has attended this innovation would seem to justify the claims of the manufacturer that the use of distillate does not increase carbon trouble. The matter of a lessened volumetric efficiency is negligible.

Tires will outwear the manufacturers' guarantee at least 25% when used on good roads. Overloading and over-speeding are the things that shorten tire life. However, the important consideration is not tire economy, but economy of truck operation per ton of material carried; therefore, durability is only one factor that must be taken into account. Resilience, which prevents the wasting of truck power; cushioning-effect, which keeps the maintenance charges low on the whole truck; a good tractive grip, and a reasonable cost are all properties which are required in a truck tire.

Operating Costs. In discussing motor-truck costs it is not possible to neglect the human factor, which here more than in most cases of machinery-handling is one of the principal items. It is hardly too much to say that maintenance costs are chiefly driver. An expensive and intricate machine is put in charge of a low-paid employee who is not the owner and who ordinarily has but a limited knowledge of machinery. This is one reason why the life of a light truck is usually about two or three years.

It is impossible for the manufacturer to devise a shop test that will equal the brutality of actual service. The modern motor truck has had to meet the demand for a vehicle that will stand abuse. The careless or indifferent driver is quick to find this out. Operating costs for the same make and capacity of truck engaged in exactly the same kind of work for one firm will frequently show a variation of 40% in the items of gasoline, oil, tires, and maintenance. It is easy to see how a poor driver will shorten the life of a truck.

Manufacturers have tried to meet this condition by making truck parts as few and simple as possible; by standardization of parts; by making wrong assemblies impossible; by printing detailed information about oiling and caring for the truck; and by instituting a follow-up service to get the truck owner started right. The truck-governor has helped to solve the speeding problem. Another aid is a recording speedometer, which gives a graphical log of each day's run—velocity plotted against time; thus every minute of the day is accounted for; the number of stops and time of each, maximum speed, etc.

Lubrication is probably the most important item in truck maintenance. Manufacturers have tried to make oiling simple and easy to do by making oiling places few and accessible, and by providing charts and printed instructions for this work; some parts every day, some parts twice a week, etc. Still, there are about seventy places in the average truck that must be lubricated, and if there is no intelligent head to look after this work, local wear soon starts and depreciation is rapid. Motor oil should be changed frequently, at least once for every 1000 to 1500 miles' run. It is not enough to build up the supply, as the oil becomes mixed with carbon and with grit from the intake air and soon loses its lubricating qualities.

In deciding upon a truck, one of the most important questions to settle is that of size. On good roads it is better to buy a truck too small for the work than to buy one that is too large. A 5-ton truck costs 25% more to operate than a 3-ton machine, nor is this cost much reduced by taking a lighter load on the heavier truck. Interest, depreciation, maintenance, taxes, insurance and fuel—all are higher.

Another point that must not be overlooked is that the capacity of a truck is figured for average conditions. A half load on a truck carried over a road full of ruts and chuck-holes is much worse for the truck than a 20% overload on a good concrete or asphalt road. A 6½-ton truck recently carried an 11-ton casting up the Mount Wilson toll road, a distance of 9 miles. This is a tremendous overload, but it can not be said that the truck was injured by it. In fact, it is probable that the truck parts were not weakened, for the road, while steep, is firm and smooth. I do not wish to encourage overloading, which has been responsible for many truck failures, but I do wish to point out that an occasional overload of 25% or even 50% when handled carefully on a good road is not objectionable, while to haul a heavy truck day after day, loaded at half capacity, is a serious matter if one would haul cheaply.

It is possible to buy a truck that is suited for work on good roads or one that is especially designed for rough roads, mud, steep hills, and severe service generally. The problem is to know what is suitable and to weigh properly the arguments of the salesman who offers a 2-ton truck with a 15-hp. motor and a 25-hp. rear axle, and the counter arguments of his rival whose truck has a 25-hp. motor and a 20-hp. rear axle. This is one of the surprising results of the modern method of making a truck from assembled parts, and while for some particular service, there may be advantages of

such variations in the relative strength of truck parts, it is a fact that both extremes are being sold for exactly the same work. The Society of Automobile Engineers has done an important service in standardizing the parts for auto trucks.

Methods of Reducing Trucking Costs. To get a low cost per ton-mile, it is necessary to keep the truck moving. Devices which cut down the time of loading and unloading are important. Among these are self-dumping bodies for various kinds of stone, hot asphalt or lumber; loading-chutes on bins which are filled by elevator or conveyor; there is also a movable steel-tipple which can be run alongside a train of flat-cars and be filled by shovelers while the truck is on the road, so

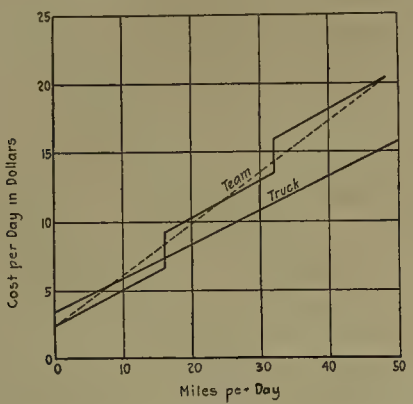


Fig. 1. Comparison of costs for 5-ton gasoline trucks and heavy teams.

that the actual time required to fill the truck is small. Another device is the use of extra truck bodies, which are loaded while the truck is on the road and swung on the truck by an air-lift or other hoist. In interurban-delivery service, loading-nests or cartridges are being used. These are filled in the store and run on the truck. There is some promise in the extension of this device for relieving the congestion around freight stations and also for interurban service where a heavy truck can bring all of the orders for an entire community and local deliveries be handled by light trucks each with its special cartridge.

Fig. 1 gives a comparison between the cost of operating a 5-ton gasoline-truck and heavy teams for such work as rock and dirt hauling and heavy transfer work generally. The costs are figured from actual experience based on a maximum of service per day and from an assumption as to what the costs would be if the vehicle did no work. The curves show that the truck should have enough work to do to occupy the time of more than one team, if it is to be the cheaper vehicle. The Pacific Electric Railway Co. uses heavy trucks for patching the paving along the line. They find that for work outside the business district the truck will do the work of two to three teams, depending upon the length of haul and the size of the job; for long-distance hauling the truck will do the work of four or five teams.

In paving Vernon avenue the rock and crushed stone were delivered by teams, the average haul being about two miles. Each team delivered a 3-ton load and averaged 5½ trips per day. When work on other contracts took the teams away, the work was sublet to another contractor who took the job at the same price per ton as the teams were figured to have cost. Three 5-ton trucks averaged 12 trips per day each, and carried an average of 54.7 tons per day apiece. This makes each truck equivalent to 3.3 teams, which would represent a considerable saving by the use of trucks, provided they could be kept steadily employed.

Barring-Down

The following, by William McCarthy, of the West Colusa mine, at Butte, Montana, is from *The Ingot*, for November, 1916, and is so full of sensible suggestions that it is a pleasure to re-print it:

"When barring-down, especially in a stope where there is a lot of bar work to be done, it is a good idea to first see that your floor is good, and clean. See that there are no tools of any description or loose lagging for you to trip and fall over. You may have to make a quick jump backward or sideways to avoid a falling rock, for one can never tell which way a rock is going to bounce when it hits a cap or girt.

"Watch your bar, for it is surprising the way a rock will slide down a bar and give you a cut or bruise; and often you may get a whole lot more than you really expect.

"Never stand behind a man using a bar, but if possible stand where you can watch the ground, for you may notice a seam or crack open up that he has failed to see.

"Try to avoid barring over a cap or girt, for a rock may strike the end of the bar and a broken arm or jaw-bone may be the result."

To the above we may add: never bar-down with a bar so short that the end does not pass your side, for barring-down with a short bar—one that when reaching up, brings the lower end directly in line with your body, introduces an element of great danger that with a longer bar may be obviated.

De-tinning of scrap tin-sheet, old tin cans, and other articles of tinned sheet-iron is about to become an important industry at Birmingham, England, where a corporation has been organized to undertake this business. This industry had reached importance in Germany before the War. In the United States every large city could supply enough old tinned material to justify a plant for the recovery of the tin. The cost of the Birmingham plant for de-tinning scrap-tin will cost $15,000.

Amalgamating-plates are said to be discolored by black oxide of manganese. A solution of 16 oz. hydrochloric acid in 5 gal. of water will remove the objectionable film, but it requires vigorous scouring with a brush or piece of gunny-sack to accomplish the desired result.

Influence of Silver on Gold Recovery From Sulpho-Telluride Ore

*A recent report by the metallurgical staff of the Great Boulder Perseverance mine at Kalgoorlie contained the following interesting note:

The residue averaging 0.742 dwt. (74.2 cents) is above normal. Treatment conditions were good throughout the month. Roasting was better than the standard required (that is, 8 cc. $\frac{N}{10}$ iodine reducing value per 100 grams of ore), and in ordinary circumstances should have resulted in residue valued at 0.54 dwt. per ton. During the early portion of the period $5.43 gold and 3.3 dwt. silver; and the residue 60.8c. gold and 1.74 dwt. silver. From the 10th there was a rapid rise in the heads, also in the residue. The roasting-furnaces were working with normal load, giving an average roast of 6.8 cc. $\frac{N}{10}$ iodine; without alteration of feed to the roasters the iodine test rose to 10 cc. for two days, the feed was then reduced by 100 tons per day until 6 cc. $\frac{N}{10}$ iodine and under was the daily average roast. The residue, however, did not return to normal, and for the remainder of the month averaged 80.9c. gold and 3.05 dwt. silver, the ore assaying $6.74 gold and 8.04 dwt. silver. The reduction of feed to the roasters, higher strength of cyanide solution, and increased alkali, with longer period of agitation, were tried, but did not bring about the desired result. The reason for the higher value of the residue, so far as can be ascertained, is due to the unusually high silver-content of the ore.

Preliminary investigations in the laboratory lead to the belief that it is easier to dissolve gold *per se* than when combined with silver, and as the latter increases so does the rate of solution of the gold decrease. It was found in the first trials carried out with alloys of varying fineness that the solution-ratio is as follows:

	Fineness		Solution-
Test	Gold	Silver	ratio
1	1000	0	1.75
2	800	200	1.63
3	600	400	1.33
4	500	500	1.22
5	200	800	1.02
6	0	1000	1.00

It is interesting to note that the above solution-ratios, 1 for silver and 1.75 for fine gold, bears a close agreement with the ratio of the atomic weights of these two elements, silver 108, gold 197, silver 1, gold 1.82.

In the re-treatment of residue from the roasting-plants of this field the following facts are gathered:

The Great Boulder Proprietary pumps its residue to the dump approximately one mile from the plant. The settled solution or water immediately recovered from the dump passed through zinc-boxes, and the bullion fineness is gold 600, silver 400, whereas the bullion recovered from the mine is: gold, 819; silver, 161; and base, 20. This would seem to indicate that the comparatively silver-free gold is the first to dissolve and the silver-gold alloy is with more difficulty recovered. In the re-treatment of residue produced from this mine in 1905, and now being treated by lessees, the bullion has a fineness of but 400 gold and 600 silver. Both instances quoted seem to verify the belief that where silver, in combination with the gold, is unusually high, there is difficulty in producing a low-gold residue.

The following minerals are known to occur in the ore, and are often intimately associated with one another: hessite, Ag_2Te; petzite, $(AgAu)_2Te$, ratio, gold 1, silver 3; sylvanite, $(AuAg)Te_2$, ratio, gold 1, silver 1; calaverite, $(AuAg)Te_2$ and $AuTe_2$, ratio, gold 6, silver 1, and free gold of varying fineness, that is, in size.

In these circumstances the gold and silver contents may come into the plant in such a variety of ways, that it would not be correct to lay down the axiom, that high silver-content in conjunction with the gold would always result in higher gold-value in the residue. Free gold associated with hessite would probably have no effect; nor free gold with calaverite and hessite; whereas either petzite or sylvanite in which the Au and Ag is chemically combined, the gold may be more difficult to dissolve. It would be quite impossible from the daily assays of the head and residue samples for Au and Ag to say, with any degree of accuracy, in what way the mineral-contents came in; it is also outside the range of chemical analysis even to determine the several minerals in such minute quantities.

Any finality of opinion on such an abstruse question can only be deduced from general results and the known facts observed from time to time in metallurgical practice.

*Abstract from *Monthly Journal* of Chamber of Mines, Kalgoorlie, Western Australia.

THE freezing-point of mercury has been definitely determined by the U. S. Bureau of Standards. It has long been popularly supposed that mercury freezes at 45° F. below zero. The recent investigation shows this to be an error. Mercury freezes at −38.87° C. (−37.97°F.) The information is important to those who make industrial use of mercury, and particularly to the manufacturers of mercurial thermometers.

THE United States is exporting crude steel at the rate of over 1,200,000 tons annually. In August last over 160,000 tons was shipped abroad.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

THE FIRST reported discovery of gold in the United States was in the State of Georgia in 1829.

HEAVY LOSS of quicksilver per ton of ore treated in a stamp-mill indicates that the 'quick' is being over-fed. It is more likely to happen where the ore is very low-grade than elsewhere.

RUBBER GASKETS in steam-joints, such as flanges and unions, can be prevented from adhering to the surface of the metal by rubbing a little graphite and oil on the surface of both gasket and metal before connecting the pipe.

DURIRON, an acid-resisting alloy used in chemical works, laboratories, and where acids are flowing, consists of 14 to 14.5% silicon, 0.25 to 0.35% manganese, 0.2 to 0.6% carbon, 0.16 to 0.2% phosphorus, and under 0.05% sulphur, the remainder being iron. Its melting-point is from 2500 to 2550° F. The specific gravity is 7.

STUMPS of Norway pine submitted to destructive distillation at the Buffalo mine at Cobalt, yielded 26 lb. of oil from 106 lb. of wood charged into a retort. Further refining gave 31% of pine-oil at a temperature of 190 to 200° C. It was found by T. R. Jones that these stumps were better than other woods in the district, and distillation need not be carried above 400° C.

A HIGH ACCELERATION STRESS, due to quick start, may not on the surface appear dangerous to a wire rope, but if the comparison were made of the micro-structure of the steel before and after such stressing, a visible change would be perceptible. In hoisting and haulage work it is important to apply the load gradually, that the rope may not be subjected to sudden stresses, which decrease wire-rope life.

ZINC ORES of New Jersey differ materially from those generally mined throughout the West. The New Jersey ores consist of a mixture of franklinite, zincite, and willemite in a gangue of garnet and calcite. The ore is crushed and run through a magnetic separator which makes three products: willemite, used in making spelter; franklinite, employed in the manufacture of zinc oxide; and a mixed product also used in making zinc oxide.

TUNGSTEN minerals are frequently found in pegmatite dikes in which mica may be one of the constituents. Formerly mica was a mineral difficult to eliminate from the crushed ore in the concentration mills, but the problem seems to have been solved at the tungsten mill at Hill City, South Dakota, where the ore, after passing crushers and rolls, goes to a pneumatic jig that blows the mica away from the granular minerals before the pulp comes in contact with water. In the subsequent treatment, after removal of the mica, the pulp is passed through sizing-screens, from which the various grades go to jigs, tables, and slimers, and finally the slime is treated by flotation, and on a canvas plant.

WHEN A FRESH POOL of oil is opened, an excessive quantity of gas is generally produced with the oil. In a short time the flow of gas is greatly reduced in volume and pressure, because the gas tends to separate from the oil and escape more rapidly. Holding back the escape of the gas retards the oil production but conserving the gas prolongs the life of the well and increases the total amount of oil raised to the surface by flowing.

ALUMINUM finely powdered enters into the composition of two extremely powerful explosives. One of them, ammonal, consists of one part of aluminum and eight parts ammonium nitrate. This mixture is used to charge shells, and is one of the explosives which probably will never be employed as a propelling force for the reason that its explosive action is so sudden that no gun thus far made would be strong enough to resist it. Or, if the gun were not shattered by the explosion, the interior of the chamber would be likely to be damaged by it.

MANGANESE ore giving by analysis 30 to 40% Mn, 10 to 20% Fe, 3 to 10% SiO_2 with low phosphorus content would be classed as a manganiferous-iron ore. When earthy it is called 'wad'. An ore in which manganese equals the amount of iron present is usually smelted, making low-grade ferro-manganese. In the United States the price paid for manganese ore is governed largely by the specifications of the Carnegie Steel Co. of Pittsburg. High-grade manganese ores command a much higher price than that above described, but there is a correspondingly smaller demand for first-class ore. Numerous attempts have been made to concentrate manganese ores, but thus far without much success.

CUPRO-TUNGSTITE is one of the less common of the tungsten-bearing minerals. It has a highly vitreous lustre, a hardness of 4.5 to 5, and is pistachio green, passing to olive and leek green. In composition it is variable. One variety is tungstate of copper, $CuWO_4$, another is tungstate of copper and calcium (CaCu) WO_4. Before the blow-pipe it fuses to a black glass and colors the flame an intense green. It is easily soluble in hydrochloric acid, and gives the usual blue color on addition of tin or zinc. It occurs in the copper mines near Santiago, Chile, and in the vicinity of La Paz, Lower California. Also in the mines of the Suan Concession, in Korea, where it accompanies the ordinary calcium tungstate, scheelite. Cupro-tungstite may easily be mistaken for some of the minerals of the epidote group—zoisite or epidote, particularly the latter, some varieties of which it greatly resembles. Epidote and zoisite are much harder than cupro-tungstite, the former having a hardness of 6 to 7, being about the same as feldspar.

Copper, Lead, Quicksilver, and Zinc in 1916

The U. S. Geological Survey has published the following preliminary figures and remarks concerning the above metals:

COPPER

The production of copper in the United States in 1916 surpassed all previous records. Preliminary figures have been collected by B. S. Butler, who has received reports from all plants known to produce blister copper from domestic ores and refined copper. At an average price of about 27c. per pound the output for 1916 has a value of $520,000,000, compared with $242,900,000 in 1915 and with $189,790,000 in 1913.

The figures showing smelter production from domestic ores represent the actual production of most of the companies for 11 months, and an estimate of the output for December. The figures of a few companies for November were not available, and these companies furnished estimates for the last two months of the year. According to the data received, the output of blister and Lake copper from domestic ores was 1,928,000,000 lb. in 1916, against 1,388,000,000 lb. in 1915, and 1,224,000,000 lb. in 1913. The output of refined copper (electrolytic, Lake, casting, and pig) from primary sources, domestic and foreign, for 1916, is estimated at 2,311,000,000 lb., compared with 1,634,000,000 lb. in 1915, and with 1,615,000,000 lb. in 1913. The production of copper from the mines of the United States for 1916 was more than double that of 10 years ago and more than four times that of 20 years ago. The profit resulting from the domestic production was far greater in 1916 than in any previous year. It is probably safe to say that it exceeded $300,000,000.

According to the Bureau of Foreign and Domestic Commerce, imports of all forms of unmanufactured copper for the first 10 months of 1916 amounted to 397,594,000 lb. This compares with an import of 265,677,000 lb. for the first 10 months of 1915. The imports for the 12 months of 1915 were 315,698,449 lb. Exports of pigs, ingots, bars, plates, sheets, rods, wire, etc., for the first 10 months of 1916, amounted to 655,472,000 lb., compared with an export for the first 10 months of 1915 of 529,286,000 lb. Exports for 1915 were 681,917,000 pounds.

At the beginning of 1916 there was 82,400,000 lb. of refined copper in stock in the United States. This quantity added to the refinery production gives a total available supply of 2,393,000,000 lb. of refined copper. On subtracting from this amount the exports for the first 10 months and the estimated export for the last 2 months, it is apparent that the supply available for domestic consumption is materially greater than the 1,043,000,000 lb. in 1915, no account being taken of stocks held at the close of the year.

The average price of copper for 1916 showed a marked increase over that of the preceding year, being slightly above 27c., compared with 17.4c. in 1915. Much of the copper was sold several weeks or months in advance of delivery, and it is therefore probable that the actual average price received differs somewhat from the average of the daily quotations for immediate delivery. The general trend of the market would indicate that the actual price received may be below that indicated by the average of quotations.

Arizona made a record production. The total may reach 675,000,000 lb., compared with 432,000,000 lb. in 1915. This exceeds the total output of the United States as late as 1902. Montana, with more than 350,000,000 lb., exceeded its previous record production of 314,900,000 lb. in 1912. This compares with about 268,000,000 lb. produced in 1915. Michigan, in common with the other important copper-producing States, made a record production. The output for 1916 was 269,000,000 lb., as compared with 238,900,000 in 1915, the previous record production. Utah may show an increase of 60,000,000 over the previous record production of 175,000,000 lb. in 1915. The output from Alaska estimated at over 120,000,000 lb. compares with 70,600,000 lb. for 1915. The production from Nevada will nearly reach 100,000,000 lb., which compares with the previous largest production of 85,200,000 lb. in 1913 and with 67,700,000 lb. in 1915. New Mexico will probably reach 90,000,000 lb., compared with 62,800,000 lb. for 1915. California, with a production that may exceed 60,000,000 lb., showed a large increase over the previous record production of over 53,000,000 lb. in 1909. In 1915 the production was 37,600,000 lb. Tennessee alone among the important copper-producing States failed to show a record output. The production was probably slightly below 15,000,000 lb., as compared with over 18,000,000 lb. for 1915.

LEAD

The lead industry in 1916 made good gains in output, both in mining and smelting. The lead content of ore mined in the United States in 1916 was 622,000 short tons, compared with 561,639 tons in 1915, an increase of 60,000 tons, or over 10%. The average price of lead in 1916 was so much higher than in 1915 that the increase in value of the mine output of lead was about 50%.

The Northport Smelting & Refining Co. in March blew in the re-modeled smelter at Northport, Washington, and later in the year added two more lead furnaces, making four in all. The operation of the smelter gave an impetus to the production of lead in Washington, the output of which was four times as large as ever before. Construction on the Bunker Hill & Sullivan smelter was started at Kellogg, Idaho, and it is expected to be in operation in the spring of 1917.

The State that recorded the largest gain in lead production was Missouri, which made an increase of over 25,000 tons. Good gains were also made by California, Idaho, Nevada, Utah, and New Mexico.

The following estimates have been compiled without change by C. E. Siebenthal from reports made to the Survey, by all the lead refineries and soft-lead smelters in operation during the year. These reports give records of the actual production for the first 10 or 11 months and estimates of the output for the remainder of the year. The statistics of imports, exports, and lead remaining in warehouse have been made up from the records of the Bureau of Foreign and Domestic Commerce for 10 or 11 months, and estimates for the remainder of the year.

The production of refined lead, desilverized and soft, from domestic and foreign ores in 1916 was 579,600 tons, worth at the average New York price $78,826,000, compared with 550,055 tons, worth $51,705,000, in 1915, and with 542,122 tons, worth $42,286,000, in 1914. The figures for 1916 do not include an estimated output of 21,800 tons of antimonial lead, worth approximately $4,283,000, compared with 23,224 tons in 1915 and with 16,667 tons in 1914. Of the total production, desilverized lead of domestic origin, exclusive of desilverized soft lead, is estimated at 324,000 tons, against 301,564 tons in 1915 and 311,069 tons in 1914; and desilverized lead of foreign origin at 21,400 tons, compared with 43,029 tons in 1915 and 29,328 tons in 1914. The production of soft lead, mainly from Mississippi Valley ores, is estimated at 234,200 tons, compared with 205,462 tons in 1915 and 201,725 tons in 1914. The total production of desilverized and soft lead from domestic ores was thus about 558,200 tons, valued at 75,915,000, compared with 507,026 tons, valued at $47,660,000 in 1915, a gain of 51,000 tons.

Of this gain in domestic output, about 29,000 tons was made in soft lead, and 22,000 tons in domestic desilverized lead. In consequence of the great demand for lead a considerable quantity of secondary lead (about 7000 tons) and secondary antimonial lead (over 5000 tons) was recovered at the regular smelters. The final figures for the production of soft lead will show an increase of a few thousand tons over those here given, for the reason that the smelters and refiners of argentiferous lead undoubtedly treated more or less soft lead ore from the Mississippi Valley which in their preliminary estimates is not distinguished from silver-lead ore.

Imports of lead are estimated at 20,600 short tons of lead in ore, valued at $1,575,000; 9200 tons of lead in base bullion, valued at $1,091,000; and 6000 tons of refined and old lead, valued at $803,000, a total of 35,800 tons, valued at $3,468,000, compared with 51,496 tons in 1915. Of the imports in 1916 about 19,500 tons came from Mexico, against 47,124 tons in 1915. Exports of lead of foreign origin smelted or refined in the United States showed a great decrease. They were estimated at 9350 tons, worth $3,468,000, against 38,445 tons in 1915, and 31,051 tons in 1914. This does not include foreign lead manufactures exported with benefit of drawback, which amounted to 4744 tons in the first half of 1916. For the last three years notable quantities of domestic lead have been exported to Europe, and the total for 1916 is estimated at 108,200 short tons, valued at $14,787,000, compared with 87,092 tons, valued at $7,796,998, in 1915. The imports of lead for the first 10 months of 1916 originated as shown in the following table:

LEAD IN ORE AND BASE BULLION IMPORTED FROM JANUARY TO OCTOBER, 1916, IN SHORT TONS

	Lead in ore	Value	Lead in base bullion	Value
Mexico	8,193	$616,836	8,027	$955,949
Canada	2,260	161,482	3	198
Peru	461	44,305	48	4,528
Chile	2,322	199,880	....	.....
England	115	11,109	....	.....
Australia	896	53,749	....	.....
All other	577	48,002	18	1,747
Total	14,824	$1,135,363	8,096	$962,422

The amount of lead available for consumption during 1916 may be estimated by adding to the stock of foreign lead (domestic stocks are not known) in bonded warehouses at the beginning of the year (12,169 short tons) the imports (about 35,800 tons) and the domestic production (558,200 tons), making an apparent supply of 606,169 tons. From this are to be subtracted the exports of domestic lead (108,200 tons), the exports of foreign lead (about 9350 tons), the foreign lead contained in articles exported with benefit of drawback (about 9000 tons), and the stock in bonded warehouses at the end of the year (assumed to be the same as at the end of November, 8387 tons), leaving as available for consumption 471,200 tons, compared with 426,751 tons in 1915.

Lead began the year at New York with a price of 5.5c. per pound, the minimum price of the year, and rose to 8c. early in April, this being the maximum figure. A long decline carried the price down to 5.95c. in the early part of August. Another rise reached 7c. about the middle of September, after which the price remained stationary until early in December, when it advanced to 7.5c., and it closed the year at about that figure. The average New York price for the year was 6.8c., compared with 4.7c. in 1915, 3.9c. in 1914, and 4.4c. in 1913. The London price of lead was higher than the New York price for the first quarter, but below it for almost the whole of the last three quarters of the year. The London price started the year at £30 7s. 6d. per long ton (6.57c. per pound) and rose to £36 7s. 6d. (7.87c.) in the latter part of March. Paralleling the New York market, a long decline brought the price down to £28 (6.06c.) in July, at which it remained through the month. A sharp rise followed a decline and another rise brought the price up to £31 10s. (6.82c.) late in September. A decline to £30 10s. (6.6c.) took place early in October, after which the price remained practically stationary. The average price of lead at London during 1916 was about £31 1s. 7d. per long ton (6.7c. per pound).

QUICKSILVER

The domestic output of quicksilver in 1916, according to preliminary figures collected from the individual producers by H. D. McCaskey, was 28,942 flasks of 75 lb. each, valued, at the average domestic price for the year at San Francisco (estimated at $125.90 per flask), at $3,643,800. This was the greatest output in quantity since 1905 and not only the greatest in value since 1875 but, except the value of $4,228,538 for that year, was the greatest in the history of the domestic industry, dating back to 1850. Compared with the Survey's final figures of output for 1915, which gave a production of 21,033 flasks, valued at $1,826,912, the preliminary figures for 1916 show an increase of 7909 flasks, or 38%, in quantity and of $1,816,888, or 99%, in value.

The productive States, named in order of rank, were California, Texas, Nevada, Oregon, Washington, and Arizona, all of which increased their output except Nevada, although Arizona has produced only a nominal quantity to date and Washington had produced none prior to 1916.

The output for California in 1916 was 20,550 flasks, valued at $2,587,245, against 14,283 flasks, valued at $1,174,881, in 1915. Quicksilver prospecting and mining were generally active in California in 1916, and some of the large furnaces were worked profitably upon ores of lower grade than has ever been reported in the history of the industry. Many additions to plants, including experimental forms of roasters and condensers and concentrating appliances, were brought into use in the effort not only to increase the output so as to take advantage of high prices but also to try out new methods of recovery while the industry could afford to pay for experimentation. New retort plants were built at many of the smaller mines in California, as well as in Oregon, Washington, Nevada, and Arizona. The famous New Idria mines, in San Benito county, made a largely increased yield, and again led the country and the Western Hemisphere, and a large output was also made from the New Guadalupe and New Almaden mines of Santa Clara county, the Oceanic of San Luis Obispo, the Helen of Lake county, the Cloverdale of Sonoma county, and the St. Johns of Solano. Many of California's quicksilver mines showed increased output in 1916.

The combined output of Texas and Nevada in 1916 was 7975 flasks, valued at $1,004,052, against 6744 flasks, valued at $651,611 in 1915. In the Terlingua district of Brewster county, Texas, the Chisos mine remained the second largest producer in America, and the Big Bend, Mariposa, and Colquitt-Tigner mines, all re-opened in 1916, added further notable output.

The Goldbanks mine, in Humboldt county, Nevada, became a large producer, the Cinnabar King, Red Devils, and Lost Steers, in the new district near Mina, in Mineral county, made together an important initial output, and the Mercury and Nevada Cinnabar mines, near Ione, Nye county, continued production though on a smaller scale than in 1915.

The combined production of Oregon and Washington in 1916 was 412 flasks, valued at $51,870, against a nominal output from Oregon alone in 1915.

In Oregon there was a considerable yield from the Black Butte mine in Lane county, re-opened in 1916. In the Meadows district of Jackson county there was a small preliminary output from the Little Jean, Ranier, and Mrs. Dewey properties. In this district also a large amount of development work was done on the Mountain King property, which may become an important producer when a reduction plant is built for the ores. In Douglas county a small yield was made from

the Bowers prospect, and elsewhere in Oregon there was lively prospecting for quicksilver ores.

In Washington, near Morton, in Lewis county, considerable prospecting was done on the Morton Cinnabar and Mother Lode properties especially, and the former made a production early in the year from some rich surface ore tested in a modern retort.

Never before in the history of the industry have such prices been obtained for quicksilver as in the first three months of 1916. The average San Francisco domestic price for January was $222 per flask, and this rose to $295 for February, during which some metal is reported to have been sold for $400. The average declined to $219 in March, to $141.60 in April, to $90 in May, and to $74.70 in June. The price then steadied, and from July to December the monthly averages did not fall below $74.50 nor rise above $81.20. The year ended with an average for December of about $80 per flask. The high prices were due to large demands resulting from war conditions, which greatly increased domestic use in manufacture and kept down competing imports. Notwithstanding increased output the demand apparently absorbed about all the available metal, and few sales were reported at a rate less than $1 per pound.

For the first nine months of 1916 the imports of quicksilver were 5245 flasks, at an average value of $93.47 per flask. Of these imports, 3014 flasks came in during the first quarter of the year, 1698 flasks during the second, and only 533 during the third. The total imports for consumption for 1915 were 5625 flasks, valued at $282,752. Exports of quicksilver for the first 10 months of 1916 were 6689 flasks, at an average value of $76.01 per flask. The exports were 20 flasks for the first quarter, 1350 flasks for the second, 3444 flasks for the third, and 1875 flasks for October alone.

Altogether conditions for the quicksilver industry are prosperous. With increasing output, steady demand at high prices, decreasing imports, and increasing exports the quicksilver mines may look back upon 1916 as the best year within a generation, and the outlook for the immediate future is correspondingly bright.

ZINC

The zinc-mining and zinc-smelting industries experienced a year of prosperity in 1916. According to the best information available at this time the recoverable zinc content of ore mined in the United States was about 708,000 tons, compared with 605,915 tons in 1915, and 406,959 tons in 1914. The largest district gain was made by the Joplin region, which had an increase of over 40,000 tons. Montana made a notable gain and from the returns available seems to have taken second place, but it will require complete figures to decide. Good gains were also made by the upper Mississippi Valley region, Colorado, Tennessee, Idaho, Nevada, New Mexico, New York, Arkansas, and Washington. The Eastern States produced 148,000 tons, or 21%, the Central States 274,000 tons, or 39%, and the Western States 286,000 tons, or 40% of the total output of zinc in ore.

The following figures have been compiled without change by C. E. Siebenthal, from reports furnished by all operating smelters of zinc ores except one small plant, showing their output for the first 11 months of the year and their estimated output for December. The production of the smelter not reporting, which operated intermittently, has been estimated on the basis of its output for the first half of the year. Figures showing the imports and exports for 10 or 11 months were obtained from the Bureau of Foreign and Domestic Commerce, and to these figures have been added estimates for the remainder of the year.

There was much activity in the construction of retort zinc smelters during 1916, and considerable additions are under construction or planned for 1917. The number of retorts at the beginning of 1916 was 156,568, on July 1 it was 196,640, and at the end of the year it was 213,840, besides 13,648 additional retorts being built or planned. The Athletic Mining & Smelting Co. is building a smelter of 2400 retorts at Fort Smith, Arkansas, to be completed in March, 1917. The United Zinc Smelting Corporation is building a smelter to have 6912 retorts at Moundsville, West Virginia, which will be completed early in the year. Additions are under way at Pueblo, Colorado; Peru and East St. Louis, Illinois; and Blackwell, Quinton, and Sand Springs, Oklahoma. The Berger Manufacturing Co., of Canton, Ohio, completed plans for a smelter at Fort Smith, Arkansas, but the construction is yet in abeyance. The full retort capacity was not utilized in smelting ore at any time during the year. A large number of retorts were occupied in re-distilling prime western spelter. Many retorts were idle during parts of the third and fourth quarters of the year but resumed late in the year, though a considerable number were still idle in December.

The capacity, by States, of the regular zinc smelters, together with the additions now planned for 1917, is as follows:

	Retorts in operation Dec. 15, 1916	Retorts idle Dec. 15, 1916	Retorts to be added in 1917
Illinois	42,118	800	1,600
Kansas	37,198	6,778	....
Oklahoma	68,231	6,235	2,472
Other States	51,568	912	9,576
	199,115	14,725	13,648
	213,840		

Two new smelters using large graphite retorts were built during 1916. These were the plants of the Eastern Zinc Refining Co., at Brooklyn, New York, with 8 large retorts and 16 more under construction or planned, and of the M. Mooshowitz & Son Metal Co., at Trenton, New Jersey, with 21 retorts. There are now five such plants, with 153 retorts. Six electrolytic zinc plants were in operation in 1916. Four units of the large Anaconda plant at Great Falls, Montana, went into operation, and it is thought that the last unit will be completed about the first of 1917. The small Anaconda electrolytic plant at Anaconda, Montana, has been dismantled. The plant of the River Smelting & Refining Co., at Keokuk, Iowa, was active, and experiments were continued at the Bully Hill plant in California. The electrolytic zinc plant of the Judge Mining & Smelting Co., at Park City, Utah, and that of the Mammoth Copper Co., at Kennett, California, will be ready for operation by the middle of 1917. The Murray experimental plant of the American Smelting & Refining Co. is closed, and plans for a larger plant are abandoned for the present at least.

The production of spelter from domestic ore in 1916 is estimated at 553,000 short tons, worth, at the average St. Louis price, about $150,000,000, and from foreign ore at 105,000 tons, a total of 658,000 tons, worth $180,000,000, compared to a total of 489,519 tons in 1915 (458,135 tons of domestic origin, and 31,384 tons of foreign origin), worth $121,400,000 at the average St. Louis price. This was a gain of 169,000 tons in quantity and an indicated gain of more than $58,600,000 in value. The actual gain in value, however, was considerably less because much of the spelter was sold for future delivery at prices from 1 to 2c. below the quotations for immediate delivery. Included in the output is 11,878 tons of electrolytic spelter, of which a part was refined by electrolysis from prime western spelter. The output of zinc dust was about 2500 tons, compared with 1755 tons in 1915. The output of secondary spelter redistilled at regular smelters and at the smelters with large retorts was about 32,000 tons. It is probable that the output of re-melted spelter was not less than that of the preceding year, 23,000 tons, which would give a total of 55,000 tons of secondary spelter. Adding this to the production of primary spelter gives a grand total of 713,000 tons of spelter made in the United States in 1916.

The production of primary spelter from both domestic and

foreign ores, apportioned according to the States in which it was smelted, by six-month periods, was as follows, in tons:

State	1915 First half	1915 Second half	1916 First half	1916 Second half
Illinois	74,982	84,976	90,082	90,268
Kansas	35,247	66,176	74,592	65,924
Oklahoma	51,172	58,036	73,298	90,790
Other States	55,131	63,799	78,480	95,054
Total	216,532	272,987	316,452	342,036
	489,519		658,488	

Exports of spelter and sheets made from domestic ore are estimated at 167,000 short tons, worth $52,200,000, compared with 118,603 tons, worth $29,537,680, in 1915. Exports of spelter made from foreign ore are estimated at 43,500 tons, valued at $7,500,000, compared with 13,720 tons in 1915. The exports of zinc manufactures fell off to $573,000 in 1916, from $2,173,089 in 1915. The exports of brass are estimated at 110,300 tons, valued at $65,085,000, compared with 33,136 tons, worth $12,435,906, in 1915. Manufactures of brass were exported to the value of about $237,300,000, compared with $41,117,771 in 1915. The value of cartridges exported in 1915 was about $59,000,000, against $24,814,679 in 1915. Exports of domestic zinc ore were about 78 short tons, valued at $3992, compared with 832 tons in 1915. Imports of spelter (mostly scrap, probably) are estimated at 600 short tons, valued at about $100,000, compared with 904 tons in 1915. Zinc-dust was imported to the amount of 900 tons, worth $330,000. Imports of zinc ore in 1916 were approximately 371,000 short tons, containing about 140,000 tons of zinc and worth about $11,800,000, compared with 158,852 tons of ore, containing 57,669 tons of zinc, in 1915. The zinc imports for the first 10 months of 1916 originated as follows, in tons:

Country	Ore	Zinc-content	Value
Canada	17,899	7,195	$ 455,754
Mexico	139,803	43,096	5,368,113
France	3,884	1,422	56,542
Spain	49,769	20,541	1,385,035
Italy	12,550	5,783	394,782
French Africa	2,464	1,152	73,564
French East Indies	1,653	746	55,407
China and Hong Kong	9,541	4,569	344,192
Australia	94,584	41,707	2,574,476
Other countries	841	265	20,601
Total	332,988	126,476	$10,728,466

The apparent domestic consumption of spelter in 1916 may be computed as follows: The sum of the stock on hand at smelters at the beginning of the year, 14,253 tons, plus the imports, 600 tons, and the production, 658,000 tons, gives the total available supply—672,853 tons. From this are to be subtracted the exports of domestic spelter and sheets, 167,000 tons, the exports of spelter made from foreign ore, 43,500 tons, and the stock on hand at smelters at the end of the year (to be exact, on December 15), 17,300 tons, or a total of 227,800 tons, leaving a balance of 445,000 tons as the apparent domestic consumption. This calculation takes no account of the stocks of spelter held by dealers or consumers. On comparing the consumption in 1916 with the 364,382 tons consumed in 1915 and the 299,130 tons consumed in 1914, it appears that the indicated consumption is large, because the exports of brass and manufactures of brass were large. The stock of spelter at smelters on December 15 shows a reduction of 6500 tons when compared with the 23,879 tons shown by the mid-year figures.

The price of spelter at St. Louis at the beginning of 1916 was 17.2c. per pound. By the middle of February it had risen to 20.9c., the high point of the year, after which it dropped sharply to 16.5c. by the middle of March, but rose quickly again to 19.12c. at the middle of April. Then began a long sharp decline which brought the price to 8.8c. at the middle of July. A recovery to 10.7c. was followed by a drop to 8.4c. on August 10, the lowest price of the year. By fits and starts the price rose to 13.2c. at the end of November, after which it gradually declined, closing the year at about 10c. The average price for the year for immediate delivery at St. Louis was 13.7c., compared with 14.2c. in 1915 and 5.1c. in 1914.

The price of spelter in London was uniformly about 2c. higher during the year than at St. Louis. For a few days in the latter part of November the London price was lower than the St. Louis price. The price at London opened at £90 per long ton (19.6c. per pound) and after sagging slightly through January rose sharply to £111 (24.1c.) at the beginning of March. This exceeded the maximum price for 1915, which was £110 (23.8c.). A sharp decline to £85 (18.5c.) by the middle of March was followed by a rise to £105 (22.8c.) at the end of April. The great decline then set in, which brought the price down to £44 (9.6c.) in the early part of July. A sharp recovery to £60 (13c.) at the end of July was followed by a drop to £44 (9.6c.) in the early part of August. Then followed a series of sharp oscillations, which brought the price to £60 (13c.) by the beginning of December. The price declined a little through the last month of the year and at the end was around £54 (11.7c.) The average London price for the year was about £72 7s. 7d. per long ton (15.7c. per pound).

CALIFORNIA MINERAL OUTPUT

The statistical division of the State Mining Bureau, under the direction of Fletcher Hamilton, has made a careful estimate, from information now available, of the mineral production of the State for the year 1916. This estimate is in advance of the actual figures which will be available later. The indications are that the total for all products, metallic and nonmetallic, will approximate $119,000,000, against $96,663,369 in 1915, and for the first time in the history of the State exceeding $100,000,000 in value. The major portion of the increase is due to copper. The output of that metal increased about 50% in quantity and over 60% in price per pound; more than doubling the total value of the year's product. That gold practically held its own in spite of the strike shut-down on the Mother Lode in Amador county, and an increase of about $500,000 in silver are attributable largely to the increase in copper output. Of the other important metals, tungsten, lead, zinc, and quicksilver, all made noteworthy gains. Petroleum shows an increase of about 2,000,000 bbl. in quantity and some $5,000,000 in value. As to chrome, magnesite, and manganese, it is too early yet to obtain any definite idea of the quantities, but it seems likely that the total of the three will reach at least $1,500,000. There are two new items added to the commercially productive list this year; molybdenum and strontium, small lots being sold.

The estimated values for 1916 are:

Gold	$22,500,000
Silver	1,400,000
Tungsten	4,000,000
Copper	17,000,000
Lead	1,000,000
Zinc	2,000,000
Quicksilver	2,500,000
Antimony, iron, molybdenum, platinum	59,000
Petroleum	49,000,000
Chrome, magnesite, manganese	1,500,000
Natural gas	1,800,000
Brick, cement, building stone, crushed rock, etc.	13,200,000
Miscellaneous industrial materials	1,255,000
Salines	2,100,000
Total	$119,314,000

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

PRESCOTT, ARIZONA

PRODUCTION AND DEVELOPMENT IN YAVAPAI COUNTY IN 1916.

Following is the production of Yavapai county during 1916:

Metal	Quantity	Value
Copper, pounds	108,629,600	$27,157,400
Gold, ounces	145,664	2,567,624
Placer gold, ounces	4,000	60,000
Silver, ounces	3,686,029	2,297,102
Lead and zinc concentrates		100,000
Tungsten		20,000
Total		$32,202,126

The value of the ores treated is based on copper at 25c., gold at smelters at $19, gold from placers at $15, and silver at 62½c. The value placed on lead and zinc concentrates and on tungsten is estimated, and apply only to shipments made to smelting plants outside of Yavapai county. Gold and silver are what might be termed by-products, particularly from the copper ores of the Jerome district and elsewhere.

The whole county showed considerable prosperity. During 1916, the Clarkdale smelter, operated in conjunction with the United Verde mine and, like the mine, owned by W. A. Clark, turned out 59,359,000 lb. of copper. In addition to its copper-content the ore contained precious metals sufficient to defray nearly the entire cost of mining and smelting operations. The United Verde paid 12 regular and 6 extra dividends of 75c. per share during the year, or a total of $13.50, against $6 per share in 1915. December's output will total 6,000,000 lb., and early in 1917 this will be increased to 6,500,000 lb. per month; by the middle of 1917 a monthly yield of 8,000,000 lb. is anticipated, probably to be increased to 10,000,000 lb. before next December. The Clarkdale smelter—now treating from 2200 to 2500 tons of United Verde ore daily—will be enlarged to care for the contemplated increase in ore reduced.

Early in 1917 the United Verde Extension (Little Daisy) mine, will be producing $1,000,000 worth of copper ore per month. For some time past the monthly output has been 4,000,000 lb. and the net return from $700,000 to $800,000. Most of the ore thus far shipped has been treated outside of this county at the two Douglas smelters and at the Old Dominion plant at Globe. Recently, however, shipments were discontinued to the last-named. A shortage of cars is hampering shipments. The company paid two quarterly dividends of 50c. per share on its issued 1,050,000 shares. In addition, a large treasury fund was accumulated for smelter and railroad construction, and other purposes. The ore shipped had a general average of 16% copper, against the general average of 7% in the United Verde. Ground will be broken early in January for a smelter for the Extension company. The C. V. Hopkins ranch, near Cottonwood, less than 4 miles from the company's Edith shaft, has been purchased for that purpose. A. G. McGregor, who built the Arizona Copper Co.'s smelter at Clifton, the International smelter at Miami, and the addition to the C. & A. smelter at Douglas, will superintend the work. Plans are ready for the builders, a large amount of material has been ordered, and the necessary surveys made. The surveys provide for an ore tramway from mine to smelter, and for connection with a subsidiary line of the Santa Fe at Clarkdale, and with the Southern Pacific at Mesa. The railroad and smelter will be completed within two years. The latter will have an initial capacity of at least 5,000,000 lb. of copper per month.

Another mining and smelting corporation that was successful during 1917 is the Consolidated Arizona Smelting Co., owner of the Humboldt smelter and the Blue Bell and De Soto mines. There was treated 160,000 tons of ore, yielding 12,000,000 lb. of copper, 5870 oz. gold, and 145,200 oz. silver. The total value was $3,200,000. A rumor, generally credited here,

DISTRICTS CONTIGUOUS TO PRESCOTT, ARIZONA.

is to the effect that a dividend will be declared at its next meeting in January. G. M. Colvocoresses, the general manager, is non-committal on that point. The present capacity of the plant is as follows: Concentrator, 250 tons of ore daily; smelter, 500 tons of ore daily. The capacity of the former is to be increased within a short time to 500 tons. Two additional Wedge roasters are now under construction at the smelter; when completed they will increase the smelting capacity to at least 600 tons. The company's plans for next year

provide for an increased production from the Blue Bell and De Soto mines.

The plant of the Bradshaw Reduction Co. (formerly the Randolph-Gemmill) was also successful last year. Prior to last March it was run only experimentally. From then until September 26, when it was closed pending mechanical changes and an increase in capacity from 70 to 150 tons daily, the plant treated 9300 tons of tailing from the Crown King dump. Fifty-five carloads of iron concentrate was shipped from the plant to the Humboldt smelter during that period. The concentrate carried about $18 gold, $6 silver, and $10 copper per ton and netted $45,000. In addition, 800 tons of zinc concentrate was shipped to smelting points in Kansas and Oklahoma at a net profit of more than $30,000. The plant will resume operations early in March, and after treating the remaining 2500 tons of Crown King tailing will handle ore from the Crown King, War Eagle-Gladiator, Wildflower, and other mines of the Crown King district. The properties specifically mentioned are held under lease and option by the Bradshaw Reduction Co. The Crown King is one of a number in Yavapai county and other parts of Arizona formerly worked profitably by Frank M. Murphy and others. It has a production record of upward of $2,000,000.

The Commercial and Copper Chief mines produced a considerable quantitiy of ore during 1916, and may be depended upon to increase this during 1917. The first mentioned, in Copper Basin, 8 miles from Prescott, is owned by the Phelps-Dodge interests. Its present capacity is 100 tons of 7% copper-oxide ore daily. This ore is used as a flux by the local and outside smelters. The shaft at the Commercial is to be deepened during 1917 with the object of opening ore in the sulphide zone. The Copper Chief, near Jerome, is shipping three carloads of copper ore per week to outside smelting points, and in addition is sending an average of 100 tons of gold-silver ore daily to the mill near the main shaft. Ore reserves in the mine are, however, somewhat depleted, owing to the fact that they were drawn upon extensively during 1916 and that no effort has been made to open the orebodies at deeper levels. It is understood that the shaft is to be deepened during 1917.

In the latter part of 1916 the 150-ton mill of the Stoddard Mining & Milling Co. began treating copper-gold ore from the Binghampton mine with satisfactory results, using oil flotation. Early in 1917 the plant's capacity is to be increased to 300 tons daily, with the object of treating ore from the Copper Queen mine, in addition to ore from the Binghampton.——The old Treadwell smelter—renovated and modernized—was blown-in about the middle of December. It is now owned by the Great Western Smelting Co., and will be used for reduction purposes by the Big Ledge company. The Henrietta mine, owned by this company, was recently examined by W. H. Weed, who classified it as a "good little mine."——The 80-ton cyanide plant of the Big Pine Consolidated Mining Co., 12 miles south of Prescott, began the successful treatment of ore in the latter part of 1916, as did also the Cash, the Arizona, and the Octave.

LEADVILLE, COLORADO

Discussion on Dredging in the Winter.

The following notes on the Derry Ranch dredge are of interest:

The dredge was started on April 27, 1916, but the gravel handled was small during that month, owing to the fact that the pond had to be cleared of ice before digging operations could be started. On May 1 the boat was in full swing, and continued until December 8. The yardage handled in December was comparatively small, on account of the accumulation of ice. When this dredge was built, it was contemplated that it would probably operate all winter, notwithstanding the fact that the climatic conditions are a little more severe than those encountered in any other dredging area in the States. However, it was soon noted that when the severe winter set in, the yardage handled immediately decreased and consequently operating costs materially increased. The management decided that it would be poor policy to mine the limited amount of ground at its disposal, under these much higher operating costs, when the same ground could be handled a few months later at a much lower cost. The only advantage gained would be the four months' interest on the output; this would nowhere near equal the additional cost of production. It is a question whether winter dredging operation pays, excepting where it becomes necessary, in order to hold a large and well-organized crew together. The Conrey Placer Co., of Montana, which has conducted its dredging operations throughout the winter for a number of years past, now admits that it would discontinue this practice if it were not for the necessity of keeping the crew together. This is set forth in a bulletin issued by the U. S. Bureau of Mines written by Hennen Jennings, with a closing chapter by Charles Janin (abstracted for the Press of September 23, 1916). It is a fact that the Canadian Klondike Co.'s dredges, near Dawson, operate late into the winter, sometimes almost up to the first of January, but operations of this company have not been profitable. The point raised regarding the unprofitableness of dredging operations in the winter is practically a new one, and might be treated at length. The point is that generally speaking, gold dredging operations in the winter time are not warranted, owing to the additional expense and hazards. The fact that everything is cold, difficult for the men to handle, and steel parts seem to break much more readily, all increases the digging expense.

The Derry Ranch dredge has dug 500,000 cu. yd. of gravel during the past operating season, and has recovered $120,000, and has paid out during the past year to its stockholders dividends amounting to 75% on a capital of $100,000. This might be cited as an efficient dredging enterprise and a model of what can be done under difficult conditions. Any praise along these lines should be handed to Robert F. Lafferty, the general manager, and in full charge of operations of the boat. Of course, the dredge was brought to a high state of efficiency in the designing and building, which was done by the New York Engineering Co. A. C. Ludlum is president and principal owner of the Derry Ranch Gold Dredging Co., as well as president of the New York company.

One of the greatest economies has been secured through the low-power consumption, the average being less than 100 kw. per hour. While the price of power is high, 1.65c. per kw.-hr., still the average monthly power bills rarely exceed $800, while the running time averages a little over 20½ hours per day.

The ground is heavy, containing large boulders, yet notwithstanding the high cost of power and the difficult digging it will be noted that the power bills are low for a 6-cu. ft. dredge averaging 63,000 yards of gravel per month. The ground in question consists of 125 acres, which has been proved to contain profitable gravel, the average value of all gravel dug to date being 30c. per yard. The ground was originally prospected by William H. Radford, and gold recoveries are proving the accuracy of his work.

Many difficult problems have been encountered in handling this ground, and the one that tends to restrict yardage and higher efficiency, is the necessity for avoiding damage to the adjacent ranches below the company's property. This necessitates the greatest care in dredge operations, in order to prevent muddy water from flowing onto the other ranches. Little water can be allowed to escape from the pond. When it does, it must be allowed to filter through the hay fields before it reaches the adjoining property.

This is the first and only dredging enterprise around Leadville, and it is confidently expected that more ground will be found in the near future, and that this work will be extended. In the Breckenridge district there are four dredges at work.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ARIZONA

The State Bureau of Mines considers that probably its most important accomplishment during the past year was the securing of a United States Mining Experiment Station for Tucson, to act in co-operation with the State Bureau. This means an expenditure of $25,000 annually by the Federal Government to assist Arizona in the solution of its problems. It means much more than this, as the prime object of the station is to advise ways and means for the proper utilization of the State's resources and the conservation and prevention of waste, all of which will add much to the value of the mineral production of Arizona.

(Special Correspondence.)—The Glory Hole Bonanza Mining Co. is adding a compressor to its equipment, and intends to continue exploration with increased energy. C. E. Major is manager. There is unusual activity in the Tank Pass district, 12 miles north-west of Salome, and on the north slope of the Harcuvar mountains. The Verde Velvet has men at work, and the Paystreak is prospecting. At the Cobrita group machinery is going in and development will be pushed vigorously. All of the properties mentioned have good surface showings, and the Cobrita, on which development is further advanced than on the others, looks particularly well. These mines produce copper ore containing some gold, and it is expected that with extensive development the district will come into prominence as a copper producer. The formation is granite and schist intruded by a series of parallel dikes having a northwesterly strike and steep dip. The dike-rock is much altered but resembles andesite more than anything else. The veins contain much quartz and are parallel to the dikes. Many of the veins are found at the contact of limestone with the granitic or schistose rocks, and these veins usually have calcite as well as quartz in the gangue. The Cobrita has pay-ore at the surface, chalcopyrite being abundant. The Copper Whopper, which is an old mine recently revived, has a contact vein 15 to 20 ft. wide with a well-marked gossan. The wall-rocks are limestone and schist. The latter is impregnated with copper ore.

Salome, December 27.

SALOME. It is reported that the Harqua Hala Bonanza mine has been sold to the Mudd-Jackling syndicate for $1,000,000. Martin brothers and H. W. Stevens were the owners of this Yuma County mine. A mill is contemplated for the gold-copper ore.

CALIFORNIA

CERRO GORDO. On January 10 the Cerro Gordo M. & S. Co. paid two dividends of 2½c. each. Monthly earnings are now $50,000.

GRASS VALLEY. The North Star Mines Co. is paying 50c. per share, equal to $125,000. This makes over $4,000,000 to date.

NATOMA. No. 5 dredge of the Natomas company, which has been operated for 11 years, is to be rebuilt.

(Special Correspondence.)—In the eastern part of Riverside county, overlooking the Colorado river, a few miles below the Santa Fe railroad bridge at Parker, are the Riverside mountains, which are included in the Bendigo mining district. There is considerable activity throughout the area, more than ever before, and large shipments of copper and gold ore are being made every week, especially from the Bendigo Mining Development and Calumet Mining companies, whose properties adjoin in the range. In the Bendigo are several hundred feet of development, and more than 450 tons of ore has been shipped to smelters in Arizona and at El Paso. Careful samples of ore from one of the shafts in which ore was recently cut, gave 18% copper, $2.20 gold, and 3 oz. silver per ton. Smelter returns on previous shipments gave 12% copper and $10 in gold per ton. Regular shipments of ore can easily be made as there are large bodies of commercial ore available, that can be handled at a fair profit. J. E. Meyer & Co. of Los Angeles, are large shareholders, and Lester F. Scott of Los Angeles is in charge of development.——H. E. Olund, manager of the Calumet property states that the company intends to build a smelter and install high-power machinery for carrying on development to great depth.——Other operators in the vicinity are the Calzona Mines, Steece Mines, and the Alice Mining companies. A project contemplated is to construct a spur 10 miles long from Vidal on the Santa Fe railroad to the mines of the district.

Parker, December 24.

REDDING. The Shasta copper belt is very busy, with over 2000 men employed. The new electrolytic zinc plant of the Mammoth company may start making metal in February. The Mountain Copper Co.'s flotation plant near Keswick is being doubled in capacity, or about 500 tons daily.

(Special Correspondence.)—Options were secured recently by Calvin M. Slawson on the East Belt and Conture mines, situated near Tuolumne, the prices to be paid being $10,000 and $6000, respectively. In each case three years is given in which to make payment, in the meantime the owners to receive certain portions of the gross output of the mines. Mr. Slawson will purchase machine-drills and drive the East Belt adit, now in 260 ft., an additional 300 ft. The vein will be cut at a depth of 500 feet.

A bond on the Redemption quartz claim has been given by Mrs. Eveline Ellis, of Columbia, to C. J. Bryant, of Nevada City. Of the gross output of gold, 20% is to be applied toward the purchase price, $2000, which must be fully paid within three years.

The installation of a hoist, pump, and other machinery at the Confidence mine has been completed and the work of unwatering the 900-ft. incline shaft to bottom was started a few days ago. Buildings have also been erected and electric power brought to the property. Edmund Juessen is superintendent.

The Nevada Exploration Co. has erected a head-frame and buildings on the Loney ranch, near Mt. Pass, and is sinking a shaft to an ancient river channel from which, according to report, considerable gold was taken out years ago.

Thirty tons of ore from the Bacigalupi mine, near Tuolumne, milled last week, gave returns of $48 gold per ton. Other mill runs will be made from time to time. Five men are employed at the property, which is being operated under lease by James Diamond and other local men.

It is reported that the management of the Dutch-App property contemplates installing a reduction plant at the App that will be one of the largest in the State. It will consist of three independent units. The surface plant at the Dutch, with its new flotation equipment, is modern and complete in every respect, but it is said that the proposed plant for the App will have a capacity three times that of the former.

Foreclosure proceedings involving the Longfellow mine, near Groveland, were instituted in the Superior Court of Tuolumne county today by James A. Murray. Among the numerous

defendants named in the complaint are A. G. Metz and G. L. Roberts, who are alleged to have given a note to plaintiff in April, 1912, for $16,000 secured by the mining property.

Sonora, December 29.

(Special Correspondence.)—It is reported from Westville that the old Barton or Herman mine is to be re-opened.——Gold nuggets, worth from $20 to $50 each, have been recovered in the Glen drift-gravel mine near Duncan peak. Sacramento people have the property under bond.——Work has been resumed at the Home Ticket drift-gravel mine, with 20 men.——The Pacific drift-gravel mine is also employing 20 men.——Rich gravel has been opened in the Baltimore mine at Forest Hill. More miners have been engaged.

Towle, December 21.

(Special Correspondence.)—Zabriska on the T. & T. Railway in Inyo county is becoming important as a shipping point for the ores of that district. Among those shipping are the following miners: Paddy Miles, a car of lead ore from Virgin Springs; Hugh Frazier, a car of zinc ore from the Modine mine, with another lot ready; the old Carbonate mine under lease to G. H. McLain, Julius Sheldach, and Louis Koster, is producing high-grade ore, and a carload is to be shipped shortly; this mine is owned by Jack Salisbury of San Francisco; and Jack Rogers and Chris Zabriska are shipping high-grade silver ore from the old McShane mine. Kennedy and May of Los Angeles have started development on their talc claim, as also has J. F. Clipp. Both properties are within three miles of Ibex Springs. The Rob Roy mine, owned by the Ibex Mining Co., J. F. Kent of Hollywood, California, president, has lately been re-opened, and 12 men are employed. The ore is high-grade lead and zinc.

Zabriska, December 24.

COLORADO

Coal production of this State in 1916 totaled 10,447,028 tons, an increase of 1,731,631 tons. The principal producing counties are Boulder, Huerfano, Las Animas, and Routt. There are 12,340 men employed.

Black Hawk. During 1916 Gilpin county produced metals worth $715,432, a decrease of 4% compared with 1915. Ninety mines yielded 42,000 tons of ore, a 22% drop. Gold was valued at $439,045, copper $111,474, and tungsten $100,000.

Boulder. Metal production of Boulder county last year totaled $6,632,971. Of this, 2352 tons of tungsten concentrate sold for $5,357,732. In 1915 the tungsten value was only $1,625,000.

Cripple Creek. In the Cripple Creek *Times* annual mining edition, the mining editor, S. W. Vidler, reviews the events of 1916. Every part of the district shows unusual prosperity, and many old mines have proved worth while by systematic development. The year's output was $14,399,941 from 977,819 tons of ore. Some of the principal producers were: Golden Cycle, 431,800 tons for $7,785,100; Portland (3 mills), 463,852 tons for $3,652,412; smelters at Denver and Pueblo, 52,590 tons for $2,810,500; Isabella, 12,730 tons for $34,780; and four small mills, 17,347 tons for $54,316. The Roosevelt drainage-tunnel is now 2040 ft. east of the Elkton shaft, and 5665 ft. from the Golden Cycle shaft, towards which the tunnel is heading.

According to the *Rocky Mountain News* the gold output of this district declined from $13,727,992 to $12,063,390 in 1916. There was 975,270 tons of ore extracted, a decrease of 3%. The total gold output since 1891 is $346,174,379. Dividends in 1916 totaled $3,944,321, compared with $6,493,225 in 1915. The dividend-payers last year were: Cresson, $1,311,000; Golden Cycle, $360,000; Mary McKinney, $13,093; Portland, $420,000; Stratton's Independence, $165,000; Strong, $250,000; Vindicator, $360,000; Dr.-Jack Pot, $30,000; Isabella, $25,282; United, $40,000; Cripple Creek Central, $220,000; and lessees, $750,000. The Roosevelt drainage-tunnel was extended 2528 ft.

Some of the figures in the two above estimates do not agree, much less with those of the U. S. Geological Survey given in the Press of January 6.

Leadville. The 1916 metal output of this district was $2,200,000 gold, $2,228,200 silver, $673,300 copper, $1,956,000 lead, and $13,532,000 zinc, a total of $20,589,500, against $13,839,400 in 1915. The past year's yield was the largest on record. The tonnage was 738,000, against 481,620. The producers are as follows: Western Mining Co., 250; Yak Tunnel Co., 250; Iron Silver Co., 200; Sellars group, 50; Ibex and lessees, 450; Garbutt and lessees, 100; Stars (Morning and Evening), 150; Jarbeau mines, 100; Fryer Hill mines, 100; Carbonate Hill mines, 50; Prospect Mountain, 100; small lessees, 100; and local mills (dumps), 150; a total of 2050 tons per day.

Ouray. During the year ended June 30, 1916, the Camp Bird mine produced $800,925 from 25,601 tons of ore. The profit was $498,438. The total to date is $22,940,000 from 820,730 tons. Development during the year was 3936 ft. No new ore of any quantity was opened, and as the available milling ore was exhausted, work has been suspended until the lower adit has been driven 10,700 ft. To October 31, 1916, the heading was in 2944 ft. Four narrow veins were cut, carrying from 80c. to $2.40 gold, 3 to 10 oz. silver, and 18 to 50% lead. The ground is very hard, and skilled labor has been lacking, though improving.

IDAHO

Kellogg. The Bunker Hill & Sullivan Mining company's new smelter is considerably more than half completed, and construction is being rushed as fast as possible, according to Stanly A. Easton, general manager, who was in Spokane recently. The stacks have been erected, concrete has been poured for nearly all of the foundations, and a greater part of the brick-work has been done. Grading has been completed for the railroad tracks, two miles long, to serve the smelter, and the management expects to blow-in the plant by spring, probably by May. The refinery may not be finished at that time, but some metal will be made. Upward of 250 men are employed in construction. Deep development in the Bunker Hill & Sullivan mine has been attended with satisfactory results. The conditions in the bottom of No. 14 are as good as in any part of the mine. The lead-silver contents have held-up well. The property generally looks fine. The lowest level of the property, having a depth of 4400 ft. on the dip, has developments of ore that were viewed with much satisfaction by Robert N. Bell, State mine inspector, on the occasion of his recent visit. The Caledonia mine is yielding substantially; its earnings are $100,000 per month. The vein in the Keating tunnel has not been found. About 4000 ft. of work has been done there, the greater part of it in cross-cutting the footwall. Some seams have been driven on, but little lateral work has been done.

MICHIGAN

Houghton. On two levels of the Franklin mine rope-haulage is a success; the system is being applied to other levels. The Calumet & Hecla and other companies use the system also, and it is being extended.

MISSOURI

Joplin. During the last week of 1916 the ore market was uncertain in the Missouri-Kansas-Oklahoma region. The output was 7767 tons of blende, 1663 tons of calamine, and 1068 tons of lead, averaging $75, $50, and $90 per ton, respectively. The value was $863,624. During 1916 the total output of zinc concentrate was 368,000 tons, valued at $30,508,161, against 309,538 tons and $23,525,202 in 1915; and 52,195 tons of lead ore worth $4,453,832, compared with 45,313 tons and $2,513,448. The total value last year was $34,961,993, a gain of $8,900,000. Coincident with this big gain, according to the *Globe*, there has been more mill construction and greater prospect developing than in any other year in the district's history. Hundreds of thousands of dollars have been spent for new, modern mining

plants, and enormous sums for prospect drilling. With one or two exceptions, all of the centres have prospered exceedingly. While the most notable growth has been in the Oklahoma field, in the vicinity of Picher, Tar River, Century, and Baxter Springs, all parts of the field have shared generously in the unprecedented activity.

MONTANA

BUTTE. Good progress is being made in erecting the hoist at the Davis-Daly, and it is expected that the engine will be ready early in January. The new engine is a first-motion unit, having 22-in. duplex cylinders with a common stroke of 48 in. The hoist has two clutched drums, 6-ft. diameter, 56-in. face. Both drums are equipped with Nordberg axial plate-clutches and parallel-motion post-brakes. The hoist is designed to handle the following loads: Rock, 7000 lb.; skip and cage, 8300 lb.; rope, 8000 lb.; total rope pull, 23,300 lb.; depth, 4000 ft.; hoisting speed, 2000 ft. The engines are of the Corliss type and are equipped with the Nordberg four-gear reverse. Features pertaining particularly to this hoist are the use of oil for operating the brakes and clutches, and the installation of shifting-valves in the cylinder-heads. To operate the brakes and clutches by steam requires a considerable proportion of the total steam consumption of the hoist, and therefore makes a wasteful arrangement from the standpoint of steam economy. It was, therefore, decided to operate the brakes and clutches by oil furnished by a weighted accumulator. The oil supply is obtained from a triplex plunger-pump which is operated from the lay-shaft driving the valve gear, and an auxiliary motor-driven oil pump is also furnished. The hoist is equipped with a Lilly safety stop to prevent overwind, overspeeding, etc. This device is used on a number of the Anaconda hoists.

(Special Correspondence.)—At the North Moccasin property of the Barnes-King Development Co. conditions now appear more favorable for an increased production than in several months. The grade of ore was lower and costs of mining and milling higher during the last quarter, but conditions improved during the present quarter. Heavy snowfall and cold weather has interfered with the operation by the lessees of the Kendall mine, which is now owned by the Barnes-King, as the ore comes entirely from an open-cut.

The Spotted Horse mine at Maiden, which has been operated successfully under lease since 1912, has been closed temporarily for repairs. It is expected that the mine will be re-opened in a few weeks.——The Cumberland continues to open well, and is now the largest producer in the Judith mountains.——The Maginness also is maintaining a good output.

The Maginness and Cumberland mines at Maiden have been compelled to follow the course of the Spotted Horse and close for the winter. Difficulty was experienced in operating the cyanide plants during very cold weather. It also proved impossible to secure coal, due both to its scarcity and to the difficulty of hauling it through the deep snow that has fallen this winter. The Cottonwood Coal Co., at Lehigh, is at present producing at the rate of 100 tons per day, its output being taken almost entirely by the Great Northern Railway. The production in Fergus county this last year, 1916, was 220,615 tons valued at $327,646, compared with 54,329 tons valued at $65,442 in 1915. Most of this came from Lehigh and was sold at practically the cost of production. A small force is employed opening the gypsum property leased by the United States Gypsum Co. near Heath. It is proposed to build a mill next spring.

Fergus county has benefited from the war prices for base metals, this resulting in considerable development being done on lead and copper claims; but the War has practically stopped the production of sapphires from Yogo, which largely supplies the world's demands. The gems are all cut in Europe, and the production is entirely controlled by an English company. The small and imperfect stones are used for meter bearings, watch jewels, etc., and since the mines have ceased operations during the last two years there is now a dearth of such stones in the market.

Gypsum claims have been located in the foothills of the Big Snowy mountains near Judith Gap. The claims are only a few miles from the railroad, and the gypsum occurs as a thick, pure bed.

Lewistown, January 3.

NEVADA

BULLIONVILLE. The Prince Consolidated company of Pioche will start its new mill at an early date. Sulphuric acid is added to the ball-mill to sulphidize the old tailing prior to flotation. Callow cells are used. A high recovery of the lead, gold, and silver is expected.

(Special Correspondence.)—A severe storm, with 15 in. of snow, and 15 to 20° below zero weather at the end of 1916,

JARBIDGE, NEVADA, LOOKING NORTH.

interfered materially with the production of the Nevada Consolidated Copper Co. Together with a shortage of coal on the Nevada Northern Railroad this will cause a decrease of production. All stripping operations were stopped, also all outside work, including construction and improvements. The suburban trains were all suspended, except the shift train to the mines, owing to want of coal. At the smelter, there is an abundance of fuel-oil and coal; but lacking to some extent at the mines.——It is said that the Giroux mine cannot obtain coal, to even start the mill, when ready, early in January.——The Ely Consolidated has been taken over by influential Salt Lake City people; C. W. Geddes is manager and W. Campbell of Cripple Creek and Goldfield, is superintendent. The boilers and hoist on the Zack shaft are being overhauled.——The Ward mine will soon be shipping ore to Utah. Recent work by those holding a bond on the property has been satisfactory in opening higher-grade orebodies, near the sulphide zone.——The old Vulcan mine in the Hunter district is shipping ore from several lessees.——The Tungstonia mine, A. R. Shepherd manager, is running continuously, being the only tungsten property in active operation.

Ely, December 27.

VIRGINIA CITY. The annual report of the Mexican company states that the mill shipped bullion worth $446,010. Of this, the Union Con., Sierra Nevada, and Ophir companies contributed $417,739. There was treated a total of 18,920 tons of ore. When the 2900-ft. level has been unwatered the east vein will be explored through the 2700-2900 ft. winze. The management is optimistic as to the results of this work.

UTAH

In its 118-page annual number the *Deseret Evening News* gives the following figures concerning 1916:

Ore production averaged 1,200,000 tons per month, worth $9,000,000. The total of $108,000,000 is almost double that of the 1915 yield. Dividends paid totaled $24,757,480, against $10,418,402 in 1915. Metal production was as under, from 261 producing mines, against 234 in 1915:

Metal and unit	1916	1915
Copper, pounds	248,300,982	187,671,188
Lead, pounds	260,648,327	199,967,437
Gold, ounces	190,027	174,591
Silver, ounces	15,820,713	12,313,205
Zinc, pounds	33,668,855	24,292,240
Arsenic, pounds	1,917,130	1,827,200
Cadmium, pounds	40,084	.....

The Salt Lake Stock & Mining Exchange traded in 40,001,030 shares, valued at $8,671,898, against 16,867,514 shares and $3,968,516 in 1915, and 3,385,956 shares and $693,483 in 1914. The Bingham district produced 13,900,000 tons of ore, valued at $80,700,000, double the value of 1915. Park City mines shipped about 100,000 tons of ore and concentrate; Tintic, 400,000 tons, double that of 1915.

AMERICAN FORK. The first mill in the district, that of the Fissures Exploration Co., was started last week. The electric-driven mill is well equipped with two sets of rolls, two trommels, Callow screen, three elevators, two roughing-tables, two sand-tables, and two double-deck slime-tables. All the tables are of the Deister make. There are also three 25-ton settling bins, three pumps with direct connection for handling water and slime. There is also a boiler heating plant in the mill. The capacity is 75 tons per day. Concentrate contains up to 38% lead, with some gold and silver.

CANADA

BRITISH COLUMBIA

Dividends paid during 1916 were as follows:

	1916	1915	To date
Consolidated M. & S.	$ 776,689	$468,016	$3,096,825
Granby	1,049,894	222,472	6,776,817
Hedley	240,000	300,000	2,063,520
LeRoi No. 2	.....	59,600	1,625,220
Rambler-Cariboo	87,500	35,000	507,500
Standard	600,000	250,000	2,400,000
Mother Lode	137,500	.....	137,500
Total	$2,891,583	$1,335,088	$16,607,382

ONTARIO

BOSTON CREEK. The Crown Reserve Company of Cobalt has taken an option on the O'Donald gold claims, on which some good ore has been found.

KIRKLAND LAKE. Wiring for the new transmission-line, 65 miles long, should be completed by January 15. The substation, of 5000 hp., is between the Tough Oakes and Wright-Hargraves mines.

The Tough Oakes company paid dividends amounting to $260,750 in 1916.

PORCUPINE. Dividends paid by companies operating in this district during 1916 totaled $4,180,750, to which the Dome contributed $800,000; Hollinger, $2,880,000; and Porcupine Crown, $240,000. The total to date is $8,920,000.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

DONALD F. IRVIN is here from Los Angeles.

C. E. KEYES, JR., of Oakland, is going to the Belgian Congo.

B. M. MCATEE spent the holidays in Denver and has returned to Miami.

RIENZI W. MACFARLANE is with the Arizona Copper Co. at Morenci, Arizona.

ARTHUR K. ADAMS has been appointed geologist to the Andes Copper Co. in Chile.

ED. C. MORSE has gone to Rye Valley, Oregon, to take charge of the Rainbow mill.

N. H. RUBY, engineer at the Butters Salvador mine, has returned to Portland, Oregon.

N. O. LAWTON, general manager for the Vermont Copper Co., is on a trip through the West.

H. C. BAYLDON has been appointed resident manager of the Spassky copper mine, in Siberia.

WILLIAM J. HAMILTON sails from New York on January 13, returning to Cerro de Pasco, Peru.

GEORGE ZOFFMAN sailed from San Francisco, on his return to Cinco Minas, Jalisco, on January 3.

JAMES NELSON, formerly superintendent of the El Favor mines, in Mexico, is at Salt Lake City.

HERBERT C. WOOLMER has resigned from the service of the Spassky and Atbasar copper companies.

ALF WELHAVEN, manager for the Oriental Consolidated Mining Co. in Korea, is sojourning at Los Angeles.

H. H. COLLEY has been promoted to superintendent of the Old Dominion mine and smelter at Globe, Arizona.

W. W. WISHON has been appointed consulting engineer to the Big Casino Mining Co., at Searchlight, Nevada.

A. R. WHITMAN, geologist to several mining companies at Cobalt, has returned thither after spending the holidays here.

J. C. RAY, who has been making a geological examination of mines at Oatman, Arizona, has returned to San Francisco for the winter.

C. A. FILTEAU has resigned as manager of the St. Lawrence Talc Co. to take the management of the National Mines, Ltd., Cobalt, Ontario.

MARK R. LAMB has resigned as manager in South America for the Allis-Chalmers Manufacturing Co., and will return to the United States.

A. S. WHELER has resigned as Inspector General of Mines to the Chinese government and is visiting the Malay States on his way back to England.

JOSEPH W. RICHARDS notifies us by telegraph that he did not sign the circular issued by the friends of SIDNEY J. JENNINGS; it was JOHN W. RICHARDS of Denver.

JAY A. CARPENTER has resigned his position, as metallurgist for the West End Consolidated at Tonopah, to become general superintendent of the Nevada Packard Mines at Rochester.

The A. I. M. E. will hold its 114th meeting at New York from February 19 to 22, inclusive. About 50 members are expected to attend. The membership totals 5922, a gain of 200 since September.

The UNIVERSITY OF CALIFORNIA has issued its register for 1915-'16, with announcements for 1916-'17. This bulletin covers every phase of college activities.

The College of Mines of the UNIVERSITY OF WASHINGTON, at Seattle, held open house at the new experiment station on January 12.

THE METAL MARKET

METAL PRICES

San Francisco, January 9.

Antimony, cents per pound	12
Electrolytic copper, cents per pound	35
Pig lead, cents per pound	7.75—8.75
Platinum, soft and hard metal, per ounce	$85—91
Quicksilver, per flask of 75 lb	$80
Spelter, cents per pound	13
Tin, cents per pound	41.50
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, January 9.

Antimony, 50% metal, per unit	$1.00
Chrome, 40% and over, f.o.b. cars California, per ton.	15.00
Magnesite, crude, per ton	6.50— 9.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO_3, per unit	18.00—20.00

Manganese remains unchanged, though considerable business is being done.

While the nominal price on 40% chromic iron is $15, buyers are offering a premium on higher-grade ore. This premium is not fixed but varies with the quality of the ore.

The average price of tungsten in the Boulder district of Colorado during 1916 was a little under $23 per unit. The output amounted to 2400 tons of ferberite concentrate. The present price is $15 per unit.

New York, January 3.

Tungsten: The market is fairly active, but quieter than it was a week ago. Exports are restricted by the necessity of obtaining permits from Great Britain to ship.

Molybdenite: The market is quiet and easier, offerings of $1.75 to $1.85 per pound MoS_2 contained having been made.

Antimony: The quotation is nominal at about $1.60 per unit.

EASTERN METAL MARKET

(By wire from New York.)

January 9.—Copper is dull, re-sale metal is easy; lead has remained quiet all week at 7.50c.; there is an evident effort being made to depress the price of spelter.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Jan.	3	Nov. 28	34.00
"	4	Dec. 5	34.10
"	5	" 12	34.37
"	6	" 19	34.04
"	7 Sunday	" 26	31.55
"	8	Jan. 2	29.90
"	9	" 9	28.20

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	14.21	13.60	24.30	July	13.26	19.09	25.66
Feb.	14.46	14.38	26.62	Aug.	12.34	17.27	27.03
Mch.	14.11	14.80	26.65	Sept.	12.02	17.69	28.28
Apr.	14.19	16.64	28.02	Oct.	11.10	17.90	28.50
May	13.97	18.71	29.02	Nov.	11.75	18.88	31.95
June	13.60	19.75	27.47	Dec.	12.75	20.67	32.89

During November 1916 the output in pounds of several of the largest copper producers was as follows: Utah Copper, 16,421,192; Nevada Con., 7,047,486; Ray Con., 6,894,736; Chino, 6,906,024. In December the production of Chino was 4,622,273 lb. and of Inspiration Con., 10,400,000 pounds.

Inspiration Consolidated pays $2 per share on January 29. Mohawk pays $10 per share on February 1, and United Verde Extension pays 50 cents on February 1. Miami Copper Co. pays a dividend of $2 on February 5.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Jan.	8	Nov. 28	73.43
"	4	Dec. 5	75.05
"	5	" 12	75.37
"	6	" 19	76.35
"	7 Sunday	" 26	76.05
"	8	Jan. 2	75.37
"	9	" 9	75.28

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90	47.52	63.06
Feb.	57.53	48.45	56.74	Aug.	54.35	47.11	66.07
Mch.	58.01	50.61	57.89	Sept.	53.75	48.77	68.51
Apr.	58.52	50.25	64.37	Oct.	51.12	49.40	67.86
May	58.21	49.87	74.27	Nov.	49.12	51.88	71.60
June	56.43	49.03	65.04	Dec.	49.27	55.34	75.70

During December silver was shipped from San Francisco to the amount of $1,998,695. The total amount of bullion and coin, both gold and silver, shipped from San Francisco during 1916 was: coin, $29,001,571; bullion, $28,250,511, a total of $57,252,082. Of this amount $12,577,262 was in silver bullion. During December silver in ores and base bullion was imported at San Francisco to the amount of $422,213.

Silver shipments from London to India from January 1, 1916, to December 6, 1916, reached a value of £3,641,000, as compared with £3,663,000 during the year 1915.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Jan.	3	Nov. 28	7.21
"	4	Dec. 5	7.32
"	5	" 12	7.73
"	6	" 19	7.69
"	7 Sunday	" 26	7.50
"	8	Jan. 2	7.49
"	9	" 9	7.50

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80	5.59	6.40
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67	6.28
Mch.	3.94	4.04	7.26	Sept.	3.82	4.62	6.86
Apr.	3.86	4.21	7.70	Oct.	3.60	4.62	7.02
May	3.90	4.24	7.38	Nov.	3.68	5.15	7.07
June	3.90	5.75	6.88	Dec.	3.80	5.34	7.55

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Jan.	3	Nov. 28	12.87
"	4	Dec. 5	13.20
"	5	" 12	12.25
"	6	" 19	11.13
"	7 Sunday	" 26	10.00
"	8	Jan. 2	9.75
"	9	" 9	9.66

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75	20.54	9.90
Feb.	5.22	9.05	19.99	Aug.	4.75	14.17	9.03
Mch.	5.12	8.40	18.40	Sept.	5.16	14.14	9.18
Apr.	4.98	9.78	18.62	Oct.	4.75	14.05	9.92
May	4.91	17.03	16.01	Nov.	5.01	17.20	11.81
June	4.84	22.20	12.85	Dec.	5.40	16.75	11.26

The New Jersey Zinc Co. in 1916 paid $76 per share on its capital of $35,000,000. Of this, August Heckscher received $2,448,264, J. P. Wetherell got $1,339,000, and S. P. Wetherell $956,536.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Date.		Dec. 26	80.00
Dec.	12 80.00	Jan. 2	80.00
"	19 80.00	" 9	80.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	39.25	51.90	222.00	July	37.50	95.00	81.20
Feb.	39.00	60.00	295.00	Aug.	80.00	93.75	74.50
Mch.	39.00	78.00	219.00	Sept.	76.25	91.00	75.00
Apr.	38.90	77.50	141.60	Oct.	53.00	92.90	78.20
May	39.00	75.00	90.00	Nov.	55.00	101.50	79.50
June	38.60	90.00	74.70	Dec.	53.10	123.00	80.00

TIN

Prices in New York, in cents per pound.

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60	37.38	38.37
Feb.	39.76	37.23	42.60	Aug.	50.20	34.37	38.88
Mch.	38.10	48.76	50.50	Sept.	33.10	33.12	36.66
Apr.	36.10	48.25	51.49	Oct.	30.40	33.00	41.10
May	33.29	39.28	49.10	Nov.	33.51	39.50	44.12
June	30.72	40.26	42.07	Dec.	33.60	38.71	42.55

Tin is strong at 42 cents.

ANTIMONY

In a quiet market Asiatic grades are quoted at 14.25 to 14.50c., New York. Despite the absence of demand, holders of the metal have marked up their prices a little.

ALUMINUM

No. 1 virgin aluminum 98 to 99% pure is unchanged at 60 to 63 cents.

Eastern Metal Market

New York, January 3.

With all the metals, the usual holiday quiet has been accentuated by a feeling of uncertainty which makes both buyers and sellers inclined to sit still and await developments.

The most important feature in copper has been offerings at concessions by second hands, including consumers. Metal for prompt delivery has appeared unexpectedly in several directions. The producers are holding firm, but selling little or no copper. The London market is weaker also.

Zinc is quiet and featureless, but prices have held steady.

Lead is dull, but firm.

Tin shows a stronger tendency, although buying has not been large.

Antimony has a firmer tone.

Reports are current that the Entente Allies have cancelled a number of munitions contracts in this country, and that new contracts will be distributed in Canada. This is logical in view of the extent to which Canadian manufacturers have been preparing themselves during the past two years to handle munitions work. The Canadian banks recently placed $50,000,000 at the disposal of the Government for the purchase of munitions and supplies, making $250,000,000 so loaned. In the last year Canada has purchased more machine-tools in the United States that in any previous year, and it is now declared that she is in a position to fill orders at the rate of $400,000,000 yearly. Patriotism is sufficient to account for the placement of war orders in the Dominion to the maximum extent.

December pig-iron production amounted to 3,171,087 tons or 102,293 tons per day, against 3,311,811 tons in November, or 110,394 tons a day. Several furnaces were banked January 1, leaving 311 active against 322 December 1. The total production of 1916 is estimated at 39,450,000 tons. The previous high year was 1913, when 30,966,152 tons was produced. The 1915 production was 29,916,213 tons.

The pressure on the steel mills is as great as ever, but operations are hampered by transportation troubles which interfere with the delivery of raw materials and finished products.

COPPER

The copper market presents a rather uncertain aspect, which, if persisting, not even the producers can continue to view with equanimity, despite the extent to which they have sold over the first half of 1917. Reference is to the fact that in the past few days consumers and second-hands have been pressing copper for sale at concessions. It would seem, however, that the rebuff which the German peace proposition received from the Entente Allies would serve to stiffen the metal market, as it has done with certain war stocks on the Stock Exchange. Electrolytic was easily obtainable for January delivery yesterday (January 2) at 28.50c. First quarter was quoted at 28c. and first half at 27.50c. Lake is about 1c. higher than electrolytic. The London market has continued to decline, the quotation yesterday for spot electrolytic being £145 against £152, December 27. Of course, the market has been quiet in the past few days because of the holidays and the absence of cables from the other side. The offerings by consumers give rise to the disquieting suggestion that if prices continue to decline it may bring about a failure to take some of the metal under contract. This is in the minds of a portion of the trade which, however, may be ultra-conservative. It may be repeated that it is deliveries and not orders which count. Meanwhile the producers have no early copper to sell and are merely watching the market. The peace talk has had its effect on the larger sizes of brass rods which are much used in munitions work and they are easier around 33c., mill. Other brass, and also copper, products, such as sheets, tubes and rods for industrial use are as strong as ever, sheet-copper being quoted at 42c. to 43c., delivery at mill convenience. Tubing is exceedingly difficult to obtain. The figures of the U. S. Geological Survey estimate the smelter production of copper in 1916 at 1,928,000,000 lb., against 1,388,000,000 lb. in 1915, an increase of 540,000,000 lb. The December exports totaled 22,682 tons.

ZINC

For over a week the market has been quiet, but prices have been steady. In the last few days of 1916 a fair business was done for first-quarter shipment at 9.50c., St. Louis, or about 9.75c., New York. For the first half, 9.25c., St. Louis, or 9.50c., New York, has been done. The brass trade has been doing but little buying. With zinc, as with copper, the market has been a waiting one. It is admitted that the course of prices depends very largely on the export demand. Should this fail, it leaves the opportunity for surplus stocks to hammer the market down. Producers' representatives who predicted 14c. spelter in January now have but little to say. A favorable turn may be given to the market by the preliminary figures on production in 1916 as announced by the U. S. Geological Survey. The 1916 production from domestic ores is estimated at 553,000 tons, against 458,135 tons in 1915, an increase of 94,865 tons. From foreign ore 105,000 tons was produced in 1916, against 31,384 tons in 1915, making the total for 1916, 658,000 tons, against 489,519 tons in 1915. The interesting fact in connection with the figures is that production is estimated to have been far below where it was placed by predictions made in 1916, which served to depress the market. In April it was pointed out that existing and contemplated capacity would make possible a production of 800,000 tons a year. Early in December it was announced by an authority that existing capacity was sufficient to produce at the rate of 761,000 tons a year. Yet the estimate of the Survey places the total 1916 production at 658,000 tons. The December exports totaled 6628 tons. The London quotation for spot yesterday (January 2) was £50 5s. against £51 10s. December 27. Sheet-zinc is unchanged at 21c., f.o.b. mill, carload lots, 8% off for cash.

LEAD

The week has been quiet with prices practically unchanged, but steady. The independent producers quote 7.50c., New York, and about 7.35c., St. Louis. The leading interest continues to quote 7.50c., New York, but it is well understood that when it sells, settlement must be on the basis of its average quotations. More business could have been done in the past week had more chemical lead been available. The U. S. Geological Survey estimates the total 1916 production at 579,600 tons against 550,055 tons in 1915, an increase of 29,500 tons. The December exports totaled only 308 tons. The London quotation for spot January 2 was unchanged at £30 10s.

TIN

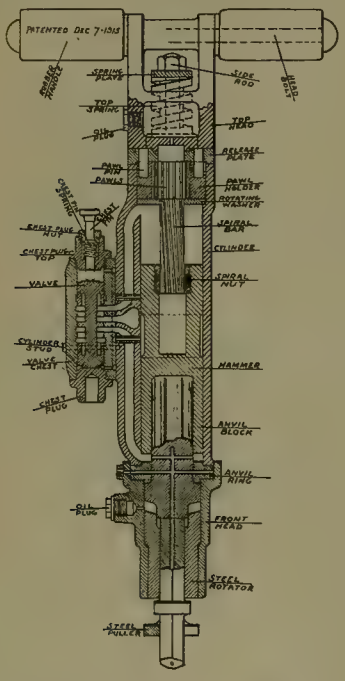
On December 27 a good business was done, between 300 and 400 tons changing hands. On the surface the market appeared very quiet on that day, the reason being that the selling was practically confined to two houses. On December 28 and 29 about 200 tons was taken. An interesting event which occurred December 29 was a sale "under the rule" on the floor of the N. Y. Metal Exchange, of 100 tons, presumably because of a dispute over a contract. For 50 tons of March delivery 40.62½c. was paid, and for 50 tons of April, 40.70c. The market stiffened yesterday (January 2), spot selling at 43c. The deliveries into consumption in December were good, amounting to 4082 tons, 1282 tons of which came via Pacific ports. In stocks and landing January 1 was 3511 tons; on the 2nd the quantity afloat was 3961 tons.

Industrial Notes

Information supplied by the manufacturers.

Self-Rotating Hammer-Drill

The Wood Drill Works, of Paterson, New Jersey, has just placed on the market a self-rotating hammer-drill that also automatically cleans the hole. If by any chance the air going through the steel is not sufficient to clean the hole, in some kinds of rock, by pressing down the button at the top of the chest, the full pressure of air is directed to the drill point, cleaning the hole of all cuttings at once. By releasing the



SECTION OF SELF-ROTATING HAMMER-DRILL.

button the drill starts automatically. One of the advantages of this drill is the absence of piston breakage; another is, no collars are required on the steels, eliminating a great deal of blacksmith trouble and expense. The hollow piston always strikes squarely on the anvil-block. The steel only requires to be cut-off squarely and tempered, and pushed up against the anvil-block of the drill. The cylinder and chest is made of vanadium-tungsten iron. It is self-oiling, and has soft rubber grips on the handle that reduce the vibration on the operator.

The San Francisco office of the DU PONT COMPANY has sent us a circular giving the advance in price of B blasting-powder, effective January 1, in California and Nevada. For less than 10-keg lots the price is $1.95 per keg; for 100 kegs, $1.70 per keg; and for car lots (800), $1.50 per keg. On the 4F granulation, the price is $2 for less than 10 kegs, $1.75 per 100, and $1.55 each for car lots.

Having purchased the plants of the U. S. Reduction & Refining Co. at Colorado City, Canon City, and Florence, MORSE BROS. MACHINERY & SUPPLY CO. has prepared a special stock list of the machinery and apparatus in these works.

The YUBA CONSTRUCTION CO. reports that Mark G. Evans of Denver just placed an order for an 8-cu. ft. dredge, electrically operated, and digging 65 ft. below water-level, for a property near Breckenridge, Colorado.

Recent Publications

ANNUAL REPORT of the Secretary of the Interior for the year ended June 30, 1916. P. 124. Washington, D. C., 1916.

ANNUAL REPORT of the Federal Trade Commission for the year ended June 30, 1916. P. 63. Washington, D. C., 1916.

NOTES ON THE WHITEFIELD COUNTY, GEORGIA, METEORIC IRONS; WITH NEW ANALYSES. By G. P. Merrill. P. 3. Illustrated.

REPORT of the Director on the operations of the Mint Service for the fiscal year 1916. P. 286. Ill., index. Washington, D. C., 1916.

SIXTH ANNUAL REPORT by the Director of the Bureau of Mines to the Secretary of the Interior, for the fiscal year ended June 30, 1916. P. 96. Index.

FLOW OF WATER IN WOOD-STAVE PIPE. By F. C. Scobey, and others. Bulletin 376. P. 96. Ill., charts. U. S. Department of Agriculture, Washington, D. C., 1916.

THIRTY-SEVENTH ANNUAL REPORT of the Director of the U. S. Geological Survey to the Secretary of the Interior, for the fiscal year ended June 30, 1916. P. 185. Ill., maps, index.

SUBSIDENCE RESULTING FROM MINING. By L. E. Young and H. H. Stoek. Bulletin 91. P. 205. Illustrated. Engineering Experiment Station, University of Illinois, Urbana, 1916.
This is a valuable discussion, of world-wide interest.

TWELFTH REPORT of the Director of the State Museum and Science Department of New York. Also 69th report of the State Museum, 35th report of the State Geologist, and report of the State Paleontologist for 1915. P. 192. Ill., maps, index.

U. S. Bureau of Mines, Washington, D. C., 1916:
UNDERGROUND LATRINES FOR MINES. By J. H. White. Technical Paper 132. P. 23. Ill., plans.
ACCIDENTS AT METALLURGICAL WORKS IN THE UNITED STATES IN 1915. Compiled by A. H. Fay. Technical Paper 164. P. 19.

Engineering Experiment Station of Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa, 1916:
SEWAGE DISPOSAL FOR VILLAGE AND RURAL HOMES. By C. S. Nichols. Bulletin 41. P. 29. Ill., plans.
STUDY OF OIL ENGINES IN IOWA POWER-PLANTS. By H. W. Wagner. Bulletin 42. P. 159. Ill., charts.
PRACTICAL HANDLING OF IOWA CLAYS. By H. F. Staley and M. F. Beecher. Bulletin 43. P. 48. Charts.

U. S. Geological Survey, Washington, D. C., 1916:
PETROLEUM IN 1915. By John D. Northrop. P. 202. Charts.
GYPSUM IN THE SOUTHERN PART OF THE BIGHORN MOUNTAINS, WYOMING. By C. T. Lupton and D. D. Condit. Bulletin 640-H. P. 19. Charts, map.
OIL-SHALE IN NORTH-WESTERN COLORADO AND ADJACENT AREAS. By D. E. Winchester. Bulletin 641-E. P. 60. Ill., maps.
ANTICLINES IN CENTRAL WYOMING. By C. J. Hares. Bulletin 641-I. P. 47. Charts, maps.
COLORADO SPRINGS FOLIO. By G. I. Finlay. P. 15. Ill., maps, charts, etc.
GALENA-ELIZABETH FOLIO. Illinois-Iowa. By E. W. Shaw and A. C. Trowbridge. P. 13. Ill., maps, charts.
Water-Supply Papers:
ARTESIAN WATER FOR IRRIGATION IN LITTLE BITTER-ROOT VALLEY, MONTANA. By O. E. Meinzer. No. 400-B. P. 29. Ill., maps.
ACCURACY OF STREAM-FLOW DATA. By N. C. Grover and J. C. Hoyt. No. 400-D. P. 7.
PACIFIC SLOPE BASINS IN CALIFORNIA. By H. D. McGlashan and F. F. Henshaw. No. 361. P. 514: Ill., index.

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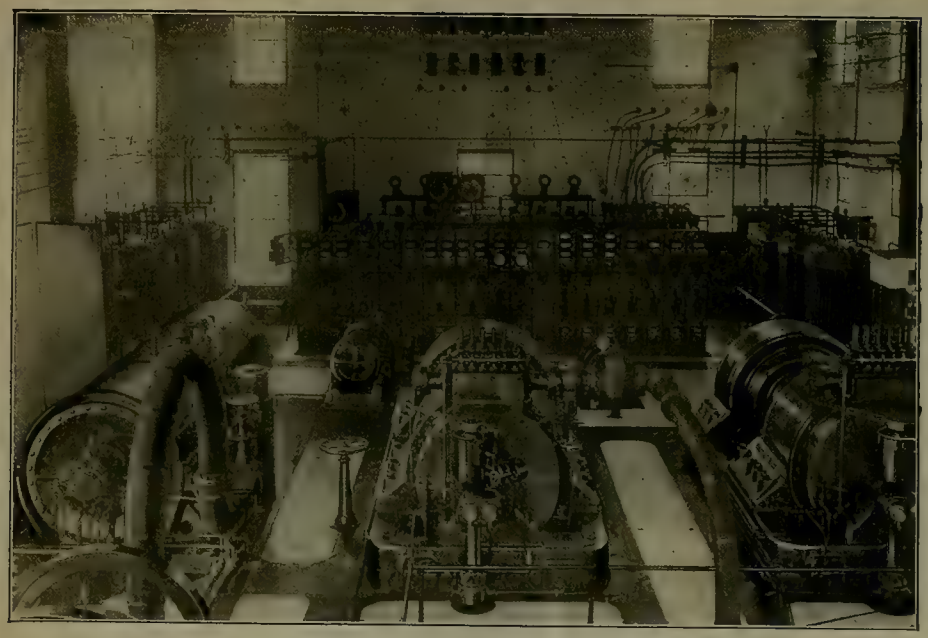

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EDITORIAL

T. A. RICKARD, Editor

THE scarcity of cyanide is compelling mill-men in the United States and Mexico to ascertain whether they cannot substitute flotation in place of cyanidation in the treatment of gold and silver ores.

WHAT zinc mining has done to make men rich is indicated by the record of the New Jersey Zinc Company in 1916. Last year $26,600,000 was distributed in dividends; of this two shareholders drew over $2,000,000 each and three others received over $1,000,000 apiece.

ACCORDING to Government statistics the United States produced 2,311,000,000 pounds, or 1,155,500 tons, of copper in 1916. This includes metal smelted from imported ores. The domestic production was 964,000 tons. This compares with an American production of 612,500 tons in 1913 and a world's total output of 1,100,000 tons in the year before the War.

DIVIDENDS from the gold mines of the Rand show a further decrease for 1916, the total being £7,139,386, a diminution of £500,000 as compared with 1915. In 1909 the total of dividends was £9,523,500. The decline is due in part to the War, which has increased the cost of supplies and machinery, but it is due mainly to the impoverishment of the mines as they become deeper. The logic of facts is incontrovertible.

DOMESTIC production of lead in 1916 was 324,000 tons of desilverized lead and 234,200 tons of soft lead, making a total of 558,000 tons, worth $75,915,000. The production from imported ores was 21,400 tons. Imports were 35,800 tons and exports 117,550 tons. The average price was 6.8 cents per pound, as against an average of 4.7 cents in 1915. In 1913 the domestic lead production was 436,430 tons.

REFERRING to the duration of an American patent that is a duplicate of a British patent, a change in the law was made in 1897. Prior to that year United States patents expired when the first corresponding foreign patent came to an end. In 1897 the law was changed so as to give the American patent its full 17 years, instead of the 14 years or less that it had previously. The law became effective as to all applications filed after January 1, 1898.

WHILE on our way home in the evening many of us have lingered to watch the driving of the piles, 115 feet long, that are preparing a foundation for the Southern Pacific Railway company's new building. What makes it so fascinating to watch a pile being driven into the ground? Is it not the conquest of mind over matter —of a machine directed by intelligence overcoming the inertia of a senseless piece of timber? To us also there came back Ambrose Bierce's remark about persons whose understanding "is like a pile driven into the mud, the more you hammer it with fact the less there seems to be of it."

ANOTHER big mine of the disseminated-copper type is reported as being in course of development, not in Arizona, but in Siberia. It is in territory controlled by the Irtysh Corporation and near the Ekibastous coalfield, where that company has engineering shops and other necessaries for rapid exploratory work. This district is part of the Altai region. Among the engineers mentioned in connection with this important prospect is Mr. R. Gilman Brown, formerly well-known in San Francisco.

ANACONDA made a new record of production in 1916, supplying the world with 336,900,000 pounds of refined copper, of which all but 24,000,000 pounds came from the company's own mines. Among the new producers Chile Copper yielded 6,118,000 pounds in the month of December, but rapid expansion of output is hindered by lack of shipping facilities. This company's Chuquicamata mine was expected to be producing ten million pounds by 1915, and it may attain that figure during the coming summer. Three or four years more are likely to pass before another 10,000,000 pounds is added to the monthly production.

GEOLOGY is a science that lends itself to the constructive imagination. That may be one reason why we are given so many "delirious trimmings," as the old lady said. For instance, in the columns of our learned 'contemptuary' at New York we read that "during the Devonian and Carboniferous ages great beds of limestone were deposited conformably on top of the sandstone" and that "the first faulting occurred during pre-Cambrian times, faulted the schists, diorites and enclosed orebodies, but not the overlying strata and lavas." It is gratifying to learn from a 'savant,' as the daily press would label him, that a valuable part of the earth known as the Jerome mining district was saved from so painful an experience as having its Devonian sediments dislocated during pre-Cambrian time.

LACK of cyanide has compelled the Santa Gertrudis company, at Pachuca, to suspend milling operations. At the recent annual meeting, the chairman, Mr. F. W. Baker, explained that no cyanide could be obtained from

Germany for obvious reasons: the American market is closed because that market "is mainly supplied by a German house now on the black list," and the English—chiefly Scottish—supply is diverted by Government enactment to the gold mines in the British dominions. In consequence of this inability to procure cyanide, the metallurgists of the company are making tests with flotation, with a view to recovering the silver in a concentrate that will be saleable to the Mexican smelters. We hope that those smelters will not be put on Villa's black list. The flotation tests have given good results. Thus does the Great War affect metallurgical development. Incidentally, we note, with pleasure, that the directors voted a bonus of $5000 to Mr. Hugh Rose, the manager, "in recognition of his untiring efforts and the excellent work performed by him during the very trying conditions that have existed in Mexico for several years past."

STATISTICS of gold and silver production are given on another page. The output of gold in the United States during 1916 is estimated to have decreased $8,719,300 as compared with 1915, while the output of silver decreased in quantity by 2,077,275 ounces but increased in value by $10,560,000, the average price of silver having been 65.8 cents in 1916 and 49.69 cents in 1915. In gold production California is again first, Colorado second, Alaska third, and South Dakota fourth. Only California produced over a million ounces. The production of South Dakota comes mainly from one mine, the Homestake. Montana is first as a producer of silver, Utah and Nevada are a close second, and Idaho is fourth. The by-product silver obtained from copper ore is an important factor in the output of silver in Montana, Arizona, and Utah. The silver of Idaho comes chiefly from lead ores. Tonopah, in Nevada, is still the most important producer of primary silver. Five States (including Alaska) contribute 80% of the gold production and four States contribute 55% of the silver. Nevada is included in both groups.

SUGGESTIONS of non-persistence of ore in depth, that is, impoverishment of mines as they become increasingly deep, have been good-naturedly derided by those directing operations in the Kolar goldfield. It is interesting to note that at the recent meeting of the Champion Reef Gold Mining Company a melancholy note of warning is sounded. "Decrease in values," meaning gold contents, is acknowledged and "any marked improvement in the mine" is said to be "hardly to be expected yet." Thus shareholders are soothed with the hope that a 'zone' of richer ore may be cut still deeper, in optimistic disregard of the fact—well known, of course, to the management—that the orebodies in the Champion Reef pitch downward from the adjacent mine —the Mysore—in which there is no evidence of lower orebodies that will enrich still deeper workings in the Champion Reef. Unless new and deeper orebodies are found in the Mysore there will be no still deeper orebodies to be worked in the Champion Reef. The Indian mines, of which only four are now active, all on the same lode, have been thriftily managed and will pay dividends for many years, but it is curious how the salient fact of impoverishment has been disregarded so long.

The Use of Flotation

The Minerals Separation company advertises that "a settlement for past infringement must precede granting of licenses for future use of the process" and that it "will enforce its patents and stop all infringements." By virtue of its ownership of U. S. patent No. 835,120, the validity of which has been upheld recently by the Supreme Court, this company is in a dominating position. A patent is property; the patentee can withhold his license to use the thing patented; he can levy what royalty he pleases; but he may find difficulty in collecting it. No direct law exists for regulating such exactions. In Canada an appeal can be made to the Commissioner of Patents against any unreasonable royalty and only a charge established by precedent can be imposed successfully; if the patentee is too grasping his victim goes to the head of the Patent-Office and he appoints a commission to adjudicate. Minerals Separation may decide to be rough with those they regard as infringers, but the latter can make the most of the law's delays. One would suppose that the Anaconda-Inspiration contract with Minerals Separation might serve as some sort of guide in establishing a royalty on copper ores, at least. We published the text of that contract in our issue of September 16, 1916. The royalty specified in that agreement is from 12 cents per ton on less than 4000 tons daily to 4 cents per ton on more than 30,000 tons, but there is a curious proviso that on the 5000 tons in excess of the first 10,000 tons—up to 15,000—there shall be no royalty, so that the royalty on 15,000 tons daily is only 6 cents per ton. Unfortunately the courts take little cognizance of any contract except the one at issue. The patent is held to afford presumption that the process is valuable. Mr. Ballot and his friends believe that their enemies—for so they regard the infringers—are delivered into their hands. The independent users of a process developed by a long series of improvements made by many men refuse to accept the implication of infringement and are as determined as ever to contest the monopoly claimed by Minerals Separation. How this can be done, we shall suggest.

Turning to the decision of the Supreme Court, delivered on December 11, 1916, we find a precise definition of the process covered by patent 835,120. Stress is laid on two limitations: (1) the agitation is obtained "by beating air into the mass" of ore and water, and (2) the use of a 'critical' proportion of oil, namely "a fraction of 1% on the ore." The Court says of the patentees that "while the evidence in the case makes it clear that they discovered the final step which converted experiment into solution, 'turned failure into success,' yet the investigations preceding were so informing that this final step was not a long one and the patent must be confined to the results obtained by the use of oil within the proportions often described in the testimony and in the

claims of the patent as 'critical proportions' amounting to a fraction of one per cent on the ore, and therefore the decree of this court will be that the patent is valid as to claims No. 1, 2, 3, 5, 6, 7, and 12, and that the defendant infringed these claims, but that it is invalid as to claims 9, 10, and 11." The three claims last designated do not mention a specific quantity of oil; they refer to "a small quantity" of it. Clearly the patent is held down to the limitation of "a fraction of 1%"—that is, less than 20 pounds of oil per ton of ore.

The fact is overlooked, by the Supreme Court and others, that the agitation-froth method was based upon the use of oleic acid in experiments on Broken Hill ore. Oleic acid is a thick oil and the Minerals Separation metallurgists recognized early that any excess of it in the pulp tends to coagulate the metallic particles into flocks so as to make them sink. The patentees of 835,120 assumed incorrectly that what was true of oleic acid was true of all oils. Since 1905 a great number of oils, of a character quite different from oleic acid, have been brought into use for the purpose of flotation.

We are able to state that 21 to 22 pounds of oil per ton of ore is now being used in several mills, notably the Arthur plant of the Utah Copper Company, without any diminution of metallurgical efficiency as compared with the smaller proportion used previously. The recovery is 88% and the tailing assays 0.12% copper. This result is being obtained on vanner-tailing, and even better flotation work is being done on low-grade vanner-concentrate. More of the cheaper kind of oil and less of the expensive kind is used, so that the extra cost is not excessive—it is within the limit of the average royalty that Minerals Separation collects from its licensees. Another interesting point is the amount of oil in circuit in a flotation plant. While two or three pounds may suffice for an experiment in court or in the laboratory, it is necessary to use many times more in the course of a working metallurgical process, so that "the fraction of 1% on the ore" —meaning dry ore, not watery pulp—becomes quite a different ratio when conducting a complete cycle of operations in a mill. In short, the amount of oil used and necessary to use in a flotation mill is many times the amount lost or consumed in the series of operations viewed as a whole process. These suggestions may prove helpful to some of our readers. There are 234 so-called infringers in the United States. They can ascertain for themselves whether they are indeed working the process inside the definite limitations set by the Supreme Court. The measuring of the oil in a pulp can be done by use of a centrifugal separator or the oil in a sample can be dissolved in ether. The expulsion of the oil by heat and the condensation of it afterward complete the test. A simple and effective method for this purpose is required and is sure to be devised without delay.

The Supreme Court limited Minerals Separation to "a fraction of 1%" of oil, and the Court also defined the process of patent 835,120 as one in which aeration of the pulp is done by "beating air into the mass," as is done by an egg-beater or a blade-impeller, but not by the quiet passage of air admitted through a porous bottom, a perforated pipe, or in similar ways. This would seem to exclude the pneumatic machines of the Callow type from the restrictions of the patent. Moreover, the Court defined the mode of agitation used by Minerals Separation as "greater than and different from that which had been resorted to before." Again, we have heard a great deal about the persistent, coherent, and miraculous froth that Minerals Separation, and only they, produced. They are held to their own disingenuous assertions. In effect, the Court says: "You present the assumption, which the evidence of the defendant has not disproved, that you produce a particular kind of froth when a specific proportion of oil is added to pulp agitated violently by a mechanical stirrer. All right, gentlemen, we grant you a patent within the limits stated by yourself, and you are welcome to make the most of it." It looks to us as if the decision might have a citric flavor, possibly now, more probably when the Miami suit comes before the Court of Appeals at Philadelphia. The Supreme Court gives Minerals Separation its pound of flesh, but no more; the company is held to just that pound, as nominated in the bond of 835,120. "An upright judge, a learned judge!"

Taxing Mines in London

In days that older members of the profession can recall, the London market played an important part in American mining, because it furnished the means of selling and floating many important mines. In later years the wealth accumulated at New York, Boston, and other commercial centres in the United States has sufficed to energize mining operations on the largest scale known to the modern world. However, London was a great distributing centre for the capital engaged in mining up to the days—now seeming so distant—before the beginning of Armageddon. The question arises whether one of the effects of the War may not be the impairment or even the destruction of the facilities heretofore afforded by London for the promotion of mining enterprise. From the information at our disposal we are compelled to consider the outlook unfavorable, if not gloomy. The extraordinary taxation incidental to the War is serious, for an income tax of 5s. in the £, or 25%, is unpleasant, especially to shareholders that are not citizens of the belligerent country in which this tax is levied. It is sufficient to deter Americans from wishing to register a company at Somerset House or to have the headquarters of a company on London Wall. Hitherto the free market for shares offered by the London Stock Exchange has been an inducement to give British domicile to an Anglo-American mining company. How long a 25% income tax will continue to be imposed and whether it may not be increased to a higher proportion, as it already is for those liable to super-tax, nobody knows. If the War should be unduly prolonged, this means of raising revenue is likely to be employed increasingly, and even after hostilities cease it is probable that no immediate diminution of the tax is to be anticipated until some of the financial burdens of the War have been liquidated.

To an American, therefore, the holding of shares in a mining company registered in London is not likely to be pleasant and the flotation of mines on the London market is not likely to be attempted. Again, the companies operating mines in South Africa, Australia, Canada, or in other British dominions, have had to protest against the payment of a double income tax, when their headquarters are in Great Britain and the mine is in one of the overseas dominions. Some measure of relief has been given to such companies by allowing British shareholders a rebate equal to the amount of the colonial income tax. If, however, the only question were that of the income tax, serious as the burden is, we might be disposed to think that the effect on the mining business of London might be temporary. There is a worse deduction: the excess-profits tax. Broadly speaking, this amounts to 60% of the surplus profit above the average pre-War standard. Where no pre-War standard exists the Act provides for a 'datum line,' as it is called, of 6%, above which this tax becomes effective. It also provides that where such a return of 6% may, for any cause arising out of the particular nature of the business, be regarded as insufficient, a higher datum line may be fixed by a board constituted *ad hoc*, known as the Board of Referees. Shortly after this Act was promulgated a belated effort was made to persuade the Treasury authorities that it was unfair and extortionate. The Institution of Mining and Metallurgy took the lead in making an organized protest by means of a representative committee, and 93 companies domiciled in Great Britain, with an issued capital of $280,000,000, subscribed to a preliminary guarantee fund to meet the necessary expense. It became apparent that the first thing to do was to establish a datum line for the whole industry of metal mining—excluding coal and iron. The real trouble is not so much the amount of the tax, although 60% plus income tax comes perilously near confiscation, as the utter capriciousness of its incidence. A company starts work in 1908 and attains its maximum output in 1914; this company pays no excess-profits tax. Another company starts work a little later, begins to make a profit in 1914, and gets into its full stride in 1916. This company pays the bulk of its profit to the Government, although its property is situated in South America and is only registered in London because it was believed that the English laws would give some protection. A third company, exactly in the same position as the second, that is registered, let us say, in South Africa, pays nothing on its excess profit. In other words, a mining company is penalized for being registered in London. Of course, examples of an even more grotesque injustice could be quoted. For instance, the Taquah company, operating in West Africa. This company, for reasons into which it is not necessary to go, allowed its development to get badly in arrears; it had to borrow $500,000, run its mill on half-time, and devoted itself mainly to exploratory and development work. Unfortunately this was done in 1912 and 1913, and it was not until 1914 and 1915 that it began to enjoy the fruits of a wise policy. Profits began to increase and the company was enabled to pay back the money it had borrowed. Now, however, it is liable for excess profits, although the profit it is earning is rather less than it was in 1910. In other words, the incidence of this excess-profits tax is largely fortuitous.

Obviously no company whose mine is in a foreign country will be willing henceforth to register in Great Britain unless the tax laws are modified. Already some of them have made a change of domicile. Even from the British point of view as expressed in letters received by us from London, it is felt that the tax on mining companies will yield comparatively little and prove of no consequence in financing the War. It affects only those that are registered in England and happen to have increased their production since 1914. These constitute a mere handful. Those whose property is in the United Kingdom cannot run away and must take their medicine, but the much larger number, situated in South Africa, South America, and elsewhere abroad, over which the British government can exercise no effective control, can and will escape the impost.

The Board of Inland Revenue and others responsible for this condition of affairs may not be directly concerned with the effect of this tax upon mining, which is treated by those in authority as the Cinderella of the imperial household, yet it is opportune to remind them that the mineral explorer was the pioneer of British expansion and that the prospecting for metallic ores was the original motive of British domination in Australia, South Africa, West Africa, Western Canada, and other large spaces now tinted red on the maps that hang in Whitehall. The Board of Inland Revenue is a synonym for all that is unsympathetic to human endeavor, but, if the matter is explained convincingly, even the mandarins of taxation might hesitate to kill the goose that lays their golden eggs. We are glad to know that the leaders of the mining profession, in England—the council of the Institution of Mining and Metallurgy—have bestirred themselves to bring the matter before the public and more particularly before those that have the say in fiscal affairs. They have begun by enunciating one or two axioms: (1) that mining is necessarily hazardous and that 15% is the minimum rate required to render profitable the use of capital in mining enterprises; (2) that a mine is a wasting asset and that an investor is entitled to a return of his capital during the life of his mine, and that therefore an amortization percentage should be added to the 15% specified above; (3) that the life of each individual mine be determined by dividing the estimated ore reserves by the annual rate of production. It is a pity that some of these axioms were not drilled into shareholders in the days before the great unpleasantness, for it must be confessed that the tax-gatherer has obtained many of his weird ideas of mining economics from the speeches of chairmen of mining companies when distributing verbal flummery to simple-minded shareholders. War is a severe teacher. We hope the lesson will be taken to heart, for, far as San Francisco may be, we speak for many of our readers in regretting any permanent injury to the London mining market.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Electrolytic Zinc at Trail

The Editor:

Sir—Permit me to correct one or two statements appearing in your issue of December 30.

In the only interview I have had with you, on the evening of August 22, last, I was very particularly careful not to make the statement that our patents were being infringed by either the Consolidated company at Trail, or by the Anaconda company. At that time I had only the vaguest idea of what was being done at Trail, and the only really definite information I have at present is derived from your issue of December 30, and that of the previous week. Any other information was merely gossip, to which I have barely listened. With regard to the Anaconda company, I have informed them that under certain circumstances they would be infringing our patents.

The management of the Consolidated company had made the statement that some of our patents are not valid, and this it was that led me to say to you that I had not, at that time, completed my search of the patent records. Since that time I have continued my search, and have found nothing which does not confirm the validity of our patents. You will recollect, too, that I mentioned to you that German patents had been granted, which, in itself, is very conclusive evidence of the validity of our patents. I have already informed you, in the interview referred to, that I have not the slightest intention of allowing myself to be drawn into any discussion of our patents, or the principles of our process at the present time, nor of our relations with the Consolidated company. Again, our company did not secure a grant of $40,000 from the Provincial Government of British Columbia. To be exact, the Government has guaranteed the debentures of our company to that amount, and has granted us the use, at a nominal rental, of the disused, but well-equipped, electric smelter which fell into its hands several years ago.

In reply to your remark that the Provincial Government, as a patron, should insist on publication of the fullest information, I may say that the late Premier, Sir Richard McBride, was quite cognizant of our treatment by the Consolidated company, and that I would not have accepted any help from the Government had they stipulated that details should be published.

In saying that Mr. J. O. Patenaude secured the Government grant previously referred to, you have been misinformed. Mr. Patenaude's help was very valuable, but he played only a minor part in securing aid from the Government. To Mr. R. F. Green, the representative for the Kootenays in the Dominion Parliament, we are much indebted for invaluable help. To him mainly is due the credit for the aid we have received, on account of his insistent representations to the Provincial Government of the value of our process, and of our claims as the pioneers in the electro deposition of zinc, not only in Canada, but elsewhere.

Nelson, B. C., January 3. THOS. FRENCH.

The Editor:

Sir—In your issue of December 30, the editorial on electrolytic zinc at Trail seems to infer that I had to do with designing the plant. The credit of this is entirely due to Mr. R. H. Stewart, Mr. Blaylock, and Mr. Guernsey, and the able staff.

I can bear testimony to the enormous difficulties overcome in bringing the plant to the operating stage in 11 months, during a period when material, machinery, and men were so difficult to obtain, and while most of the building operations were carried on in the severest winter of many years. The top of the 200-ft. stack was housed and warmed to prevent the material from freezing. Men were hard to get, as one-twelfth of the whole population of the province had volunteered and gone to the front. This included practically all of the unmarried engineers, chemists, and better class of mechanics.

Trail, B. C., January 4. E. H. HAMILTON.

Mining Law Revision

The Editor:

Sir—In your editorial note of January 6 you write, "we suggest that short of a general revision of the land laws by a competent commission, it is undesirable to repeal the extra-lateral right." Your opinion is shared by but few of those mining engineers who answered the questionnaire of the Mining and Metallurgical Society; more than 129 were in favor of doing away with the extra-lateral right "in so far as any claims hereafter to be located are concerned" and only three engineers voted to retain the extra-lateral right. And I think that this is a representative vote. The whole subject has been so fully discussed that it seems useless to give any arguments here. Dr. R. W. Raymond, in his articles in the Transactions of the Institute and in the technical journals has said about all that is needed for a full understanding of the question.

While I fully agree with J. T. Wilkins (M. & S. P.,

January 6, page 10) that a "wagon-load or so of judicial legislation shows us where we are at;" yet I do not agree that it is a good place to stop. I think that the sooner we do away with the extra-lateral right the better; if the revision of the mining law does no more than eliminate the extra-lateral right it will be quite worth while. Extra-lateral rights raise a series of problems that are absolutely unsolvable by the human intellect. As a result it is always easy to find learned professors and practical engineers who can find plenty of facts to prove the theory that suits their side of a lawsuit. And the uncertainty of the law is probably never greater than in a lawsuit involving extra-lateral right. Hence most mining engineers believe in vertical boundaries. And it is a credit to the Mining and Metallurgical Society to have obtained the expression of opinion in the vote quoted above. Let us honor those who try to do a good work and not sit on the fence and throw stones at them.

Palo Alto, January 9. W. H. SHOCKLEY.

Fighting Mine-Fires

The Editor:

Sir—The paragraph in 'Concentrates' of September 23, regarding the fires in the United Verde mine, conveys, if you will permit me to say so, erroneous impressions regarding the fire-fighting system. As I am the one who inaugurated the positive plenum system and operated it, at the United Verde, for over four years, I feel justified in briefly stating the reasons for the method as used so successfully, for the benefit of your large number of technical readers.

In the first place, before I undertook the work of fire-control there, I secured all the data possible as to the prior history of the oldest fire-zone, that in the Wade-Hampton ore-horizon. From this information, I can state that the character of the ore, though 'accessory after the fact,' had little or no bearing as to the direct origin of the fire. The fact is that 22 years ago the mining of extremely wide orebodies, such as obtain in the United Verde (one of them being nearly 500 ft. between walls), was by no means as well understood as in more recent times. These wide bodies were mined by the square-set and fill method; the filling did not keep pace with the mining, and after raising up from three to seven floors the arch of ore broke and the friction of the massive chalcopyrite with softer oxide ores caused spontaneous combustion; the sulphur content ranging from 33 to 38%. The fire condition obtained and in that day of natural ventilation the only recourse was to bulkhead the fire-zone, in the vain hope that the fire would ultimately exhaust itself. The soft and highly pyritic ores no doubt aggravated fire conditions but did not primarily cause them.

In the second place, the air pressures are not primarily maintained for the purpose of forcing back the gas to cool the ground so that work may be done, but absolutely and primarily for the purpose of killing the active combustion in the ore. Knowing that the chief product of the combustion of a pyritic ore is SO_2 and that this gas is as thoroughly extinctive in character as CO_2, I was satisfied that, by a properly regulated positive plenum system of ventilation, the SO_2 gas could be forced back on the zone of active combustion and the fire be extinguished by its own products of combustion. The success of the method has certainly shown that the theory was fairly well founded. Incidentally, the gases were held back and to a very superficial extent the ground was cooled. To what a limited extent the cooling effect progressed may be readily understood when I state that I frequently took temperatures in the ore up to 1100°F. As fresh faces of ore were broken, of course the cooling effect was progressive. We exploded dynamite in ground when the temperature was as high as from 550 to 650°. It was necessary to carefully balance the air pressure, which ranged from ½ to 1½ in. of water-gauge, depending on stope conditions. This, in brief, is a description of the fundamental principle of the method of fire-fighting in sulphide orebodies as I used it at the Iron Mountain mine, in Shasta county, California, and at the United Verde mine at Jerome, Arizona. I could burden your readers with a description of serious mining problems that arose and the effect both mental and physical on the men who were employed and the interested employers.

JOSEPH J. SHAW.

Aroroy, Masbate, P. I., November 7.

DRIVING in the Roosevelt Tunnel in the Cripple Creek district is advancing at the average rate of 5 ft. 7 in. per round of holes fired. The adit is 9 ft. wide and 8 ft. high and it requires 30 holes to the round. Little timber is required; the rock is hard—firm andesite-breccia—but water pours into the adit from every crack and crevice, the amount flowing out of the tunnel now being 10,300 gal. per minute. A drain at one side in the bottom of the adit is 4 ft. wide and 2 ft. deep. Recently 437 ft. was made during one month, working three shifts of eight men each. The adit is now in four miles from the portal and the rock broken in the face is hoisted through the Elkton shaft. It is the present intention to continue this great drainage adit to a point under the Golden Cycle shaft, 6400 ft. farther. The Golden Cycle mine is on the opposite side of the mountain from the Elkton. The adit will be about 2000 ft. below the surface at the Golden Cycle, and is expected to drain the entire group of mines in that vicinity, thus greatly prolonging the life of a number of important properties.

FINAL FIGURES, covering the 1916 operations at the San Francisco Mint, show that there was received a total of 4,213,510.773 oz. of gold—of which 1,549,318.833 oz. was Australian bullion and British coin—and 3,616,-011.34 oz. of silver—of which 2,089,881.05 oz. was coin for re-coinage. Gold bars sold weighed 908,358.875 oz. There were 52,322,500 gold, silver, copper, and nickel coins made, worth $21,204,100; also 6,065,000 pieces worth ₱345,000 for the Philippines.

Cinnabar in the Sierra Nevada

By S. L. Gillan

An unusual and interesting discovery of cinnabar was made in April 1916, in Kern county, California—unusual because of its occurrence in granitic rock, and interesting because the cinnabar lode had been exposed to the eyes of prospectors for years and until the date mentioned had remained undiscovered. It is in Sec. 27, T. 31 S., R. 32 E., M.D.M., the section where the famous loop of the Southern Pacific railroad has been built through Tehachapi Pass. J. E. Hicks, of Tehachapi, was the discoverer, and he and W. N. Cuddeback are developing the property. Six men are employed and during the past month, a Johnson & McKay retort has been in use. The retort consists of a bench of 12 pipes and during the first 23 days, 18 flasks of mercury was produced. As the plant is new, losses are to be expected, but at the date of my visit the plant was producing one 75-lb. flask of mercury per 24 hours from two tons of ore. Cordwood, which is plentiful in this locality, is consumed in retorting at the rate of 1¼ cords per 24 hours. I have not made a detailed study of the geology of this region—merely a general examination. Granitic rocks prevail; in these are lenses of dark-colored mica-schist and dikes or masses of diorite, and about a mile east of the cinnabar discovery is a belt of Carboniferous limestone that can be traced for several miles in a northwest direction. The cinnabar is found in a light-colored altered rhyolite dike that is intrusive in granite. The dike in the vicinity of the shallow excavations made by Hicks and Cuddeback strikes east-west and dips north. It projects above the surface in a rugged outcrop; the granite hanging wall is well exposed by their main excavation in a canyon that cuts the dike. Down the canyon 300 ft. from the hanging wall, granite is again exposed. This dike is the largest of a series of approximately parallel rhyolite dikes and will be referred to as the main dike. Its thickness, where the canyon cuts it, measured at right-angles to the dip, is 150 ft. About 100 ft. north of the main dike another rhyolite dike, 45 ft. wide outcrops, and 350 ft. south of the main dike a third rhyolite dike, 60 ft. thick, is exposed. In a southerly direction from the last-mentioned dike other rhyolite intrusives are seen, their dips being to the north and north-east, their strikes varying from east-west to northwest. About one-half a mile south-west from the main dike is a belt of dark colored mica-schist. . The zone disturbed by the intrusion of rhyolite dikes is 1000 ft. wide, and extends west and south-east from the place where the cinnabar is being mined. Another area of similar outcrops, presumably rhyolitic dikes, was reported by Hicks and Cuddeback to lie half a mile north of the one above described, but this was not examined by me.

The main dike is metamorphosed in places. It has been subjected to great lateral pressure, for the rock has a platy or laminated structure. It has been contorted also near the place at which it has been opened; the plates dip vertically and are brittle. The groundmass of the rock is light colored and in it phenocrysts of opalescent quartz can be seen. This sheeting is common to all the rhyolite dikes. In a number of shallow surface excavations along the main dike, within a few hundred feet, cinnabar can be seen, some of it fairly high-grade —up to 40%, according to Mr. Cuddeback. At the time of my visit an open-cut exposed the dike for a width of 60 ft. Except in a 'horse' of barren rhyolite, an iron-stained decomposed rock that occupied an area in the face 15 ft. wide and 5 ft. high, the whole face of this excavation, 60 ft. wide and 5 ft. high, contained cinnabar. On the top, and on both sides of the horse, high-grade ore was seen. The cinnabar filled seams in the rock one-eighth of an inch wide and these seams were continuous for several feet in length. In other portions of the face the cinnabar permeated the rock and it gave it a pink color over areas of several square inches. It appeared to favor the softer, more altered, and porous portions of the dike.

The furnace on the property will serve as an experimental plant and is expected to provide means for continuing the development and exploitation of this interesting prospect.

Wet Treatment of Tungsten Ores

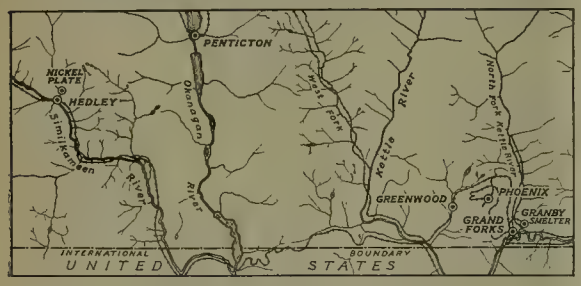
Ores of tungsten are treated by what is known as the soda process. This is usually carried out as follows: The finely ground ore is mixed with an excess of sodium carbonate and the mixture roasted in a reverberatory furnace, forming sodium tungstate. The charge is withdrawn from the furnace and ground in a ball-mill. From the grinding-mill the finely ground pulp goes to vats filled with boiling water, which dissolves the sodium tungstate; any impurities present lie on the vat bottom or float in suspension in the condition of slime. This material generally consists of iron, manganese, and gangue minerals. From the vats the sodium tungstate goes to a filter-press, from which the undissolved portions are removed. The solution passing out of the filter-press is treated with concentrated hydrochloric acid, which forms yellow tungstic oxide. This is removed, dried, and the powder mixed with pulverized anthracite, or carbon in some other form, placed in crucibles, and roasted, thus reducing the tungstic oxide to metallic tungsten, which is ground and washed to eliminate all remaining impurities, the tungsten then being in the condition of metallic powder, in which form it is used by manufacturers of steel.

LIME PRODUCTION of the United States in 1916 totaled 4,150,000 tons, an increase of 15%. This is the first year in which the output exceeded 4,000,000 tons. Pennsylvania led with 1,037,000 tons, followed by Ohio with 529,000 tons, Virginia with 350,000 tons, down to Tennessee with 120,000 tons, these being the States that yielded over 100,000 tons.

The Nickel Plate Mine and Mill

By T. A. Rickard

At Hedley, in British Columbia, a gold-bearing arsenopyritic ore in limestone has proved the basis for a highly profitable mining enterprise. The mine was discovered by two Englishmen, F. H. Wollaston and C. H. Arundel, who located four claims in 1898. The earliest location on the mountain was made by Pete Scott, who was grubstaked by Robert R. Hedley, a well-known Canadian mining engineer, formerly manager for the Hall Mines company at Nelson. His name was given to the original camp on Twentymile creek where it joins the Similkameen river. Wollaston and Arundel took some specimens of the ore to the Provincial Fair at New Westminster, where they were seen, while on exhibit, by M. K. Rodgers, an enterprising engineer whose name appears in the early story of several important British Columbian mines. Mr. Rodgers was scouting for the late Marcus Daly and was sufficiently impressed by the samples of ore to go to Hedley and inspect the prospect. After an examination



MAP OF PART OF BRITISH COLUMBIA.

he took a bond on the property for Marcus Daly. The price was $60,000 and the date November 17, 1898. The four claims then bonded were the Nickel Plate, Bulldog, Sunnyside, and Copperfield. Exploratory work was started in the January following, and exposed enough ore to warrant the completion of the transaction on December 19, 1899. The remainder of the Nickel Plate property, covering 440 acres, was acquired by purchase and location during the following three years in the name of the Yale Mining Co. In 1912 the adjoining Windfall group of 200 acres was purchased by the reorganized corporation, called the Hedley Gold Mining Co., the control having passed, in August 1909, from the Daly estate to a group headed by W. E. Cory, W. D. Thornton, C. D. Fraser, I. L. Merrill, and Chester A. Congdon—all Americans. This deal was promoted by T. Walter Beam on a report made by Walter H. Wiley, and on the further advice of I. L. Merrill, who is now the president of the company. W. B. Dickson, of the Midvale Steel Co., is the vice-president.

An important part in the history of the mine has been played by Gomer P. Jones, an Australian engineer, who came from Bendigo to New York in 1892. In August 1900 he was engaged as mine foreman by Mr. Rodgers and in August 1909, when the new company came into possession, he was appointed general superintendent, a position that he still retains, so that he has been connected with the management of the Nickel Plate for 16 years. Always full of faith in the successful development of the mine, through all its vicissitudes, Mr. Jones has combined the instinct of the miner with a useful store of practical knowledge, so that he has retained the confidence of those in control throughout the changes of ownership and has had the proud satisfaction of seeing the Nickel Plate become one of the best known and most productive gold mines in British Columbia.

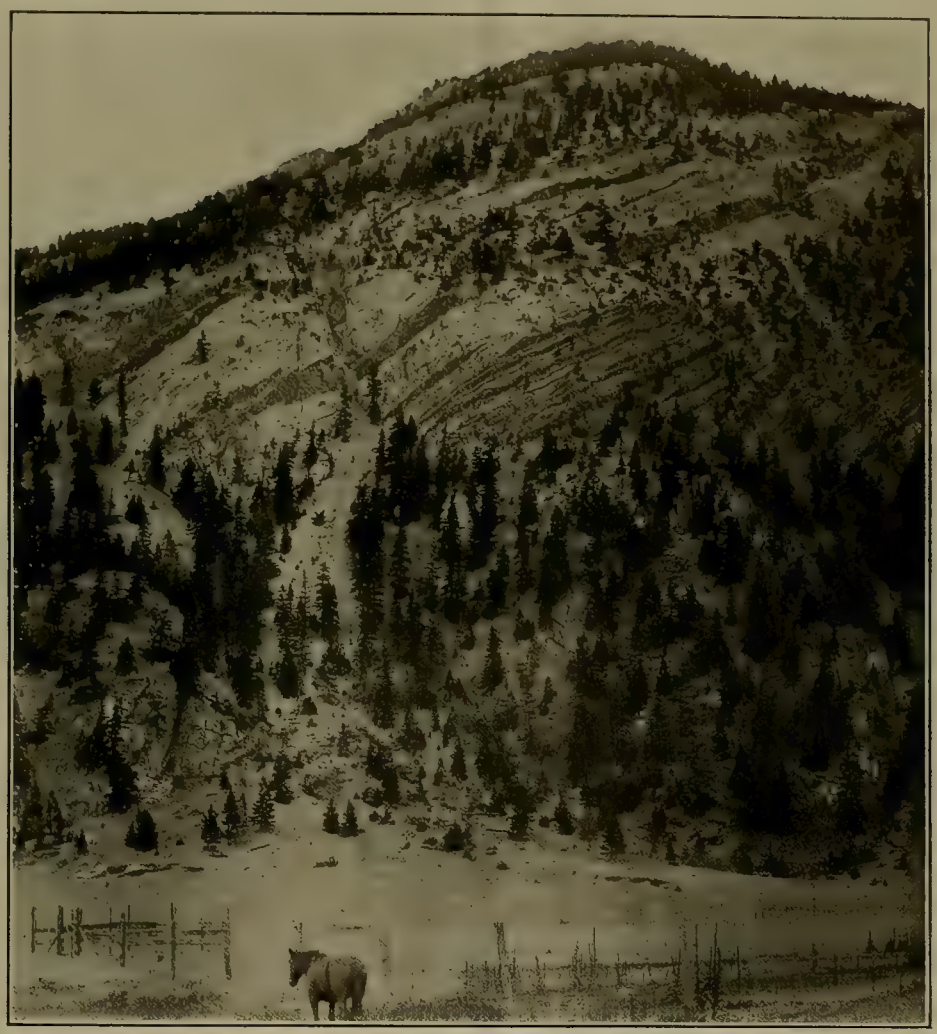
THE STIRRING MECHANISM OF THE DEVEREUX AGITATOR.

The economic geology of the district is the subject of an excellent report* written by Charles Camsell for the

*'The Geology and Ore Deposits of Hedley Mining District.' Memoir No. 2. Completed in June 1909; published in 1910.

Canadian Department of Mines. As early as 1877 G. M. Dawson gave the name of Striped Mountain to the high bluff on which the Nickel Plate mine is situated. Dr. Dawson attributed the banded appearance to the alternation of differently colored beds of limestone, quartzite, and slate; he overlooked the intrusions of igneous rock, which, by weathering to rusty brown, contribute more to the striped appearance than the sedimentary beds themselves. The ore-bearing formation consists of beds of limestone and quartzite, probably of Carboniferous age; these have been intruded by dikes and sills of diorite and gabbro emanating from a grano-diorite batholith, the top of which is exposed at the foot of the cliff near the mill. All the sedimentary rocks, but more particularly the limestone in the ore-bearing zone, have been changed by the metamorphism caused by the intrusives. The ore-bearing zone consists of a series of thin and relatively permeable beds of limestone, so penetrated by dike-rock of the gabbro phase that the calcareous matter has been highly metamorphosed, with the production of garnet, epidote, diopside, and tremolite, and the introduction of arseno-pyrite and axinite. The presence of gold in the arseno-pyrite, or mispickel, of the contact-metamorphic zone has been the means of creating rich orebodies.

The orebodies lie in overlapping succession, or *en echelon,* in the limestone, but cutting across both the dip and strike of the containing rock; Mr. Camsell says that the dip of the orebodies "is dependent on the dip of the gabbro intrusive, which forms the foot-wall. The orebodies have no apparent connection with fissures, and are not always governed by the stratification of the sedimentary rocks."



NATURAL SECTION SHOWING SILLS OF IGNEOUS ROCK BETWEEN BEDS OF LIMESTONE.

I saw the orebody in the Nickel Plate workings; it lies close to the unaltered or less silicified limestone as a foot-wall. The roof, or 'hanging,' is a much silicified limestone divided by intercalations of the so-called 'andesite.' This is the term used by the engineers at

the mine. What the correct petrographic term may be—whether 'gabbro' or 'andesite'—is less important to the miner than the fact that this particular kind of rock is associated with the finding of ore in the locality. Mr. Jones informs me that the distance from the ore-channel to the grano-diorite is 2000 ft., the interval being occupied by the limestone of the Red Top formation, with interbedded quartzite, argillite, tuff, and breccia. The Nickel Plate formation, above the Red Top series, consists of a number of thin beds of limestone and quartzite, and it is to the association of these two kinds of rock of markedly different solubility that Mr. Camsell imputes the precipitation of ore. The enriched portion of the limestone—constituting an ore-channel—averages 120 ft. in thickness, with 200 ft. as a maximum. Ore has been found for a distance of 1500 ft. on the dip and the bottom of the mine is still in ore.

The foregoing refers more particularly to the parent mine, the Nickel Plate. Conditions in the adjoining Sunnyside workings are much the same, except that in the Sunnyside No. 2 a vertical tongue, 4 to 12 ft. thick, of gabbro penetrates the limestone and on the under side of this tongue the ore is found. In the Sunnyside No. 3 a similar condition obtains, another tongue, 12 ft. thick, appearing from below at an angle of 60°. In this case the ore is on the upper side of the intrusive. These tongues may be branches or apophyses from a stock and may have afforded a passage for thermal solutions. Various dikes cross the ore-channel, but they appear to be post-mineral.

In the No. 3 workings I noted the 'frozen' contact between the limestone of the ore-channel and the gabbro. The partings between limestone beds were lined with calcite; so were the joints. The orebodies appeared flatly lenticular and overlapping downward at an inclination about six degrees flatter than the dip of the containing beds.

Dip of contacts, 22° to 23° W.

Dip of orebodies, 30° W.

Pitch of orebodies, N 40° W.

The orebody in these workings has a maximum width of 300 ft.; a maximum thickness of 40 ft., with an average stoping width of 15 ft.; while the length on the dip is shown by the map to be 900 ft. This is the longest orebody yet mined. It extends from the outcrop to a point 100 ft. below the No. 4 adit. At No. 4 I saw the diamond-drill at work and subsequently Mr. Jones showed me the core, which, in the ore-zone, exhibited brown garnet, green epidote, drab diopside, greenish blade-like crystals of tremolite, and white calcite. The richer ore is found with the lime silicates—garnet, epidote—and calcite. When the limestone changes to chert, the core is impoverished. When the arseno-pyrite is well crystallized, it is poor in gold. The axinite indicates a high gold content.

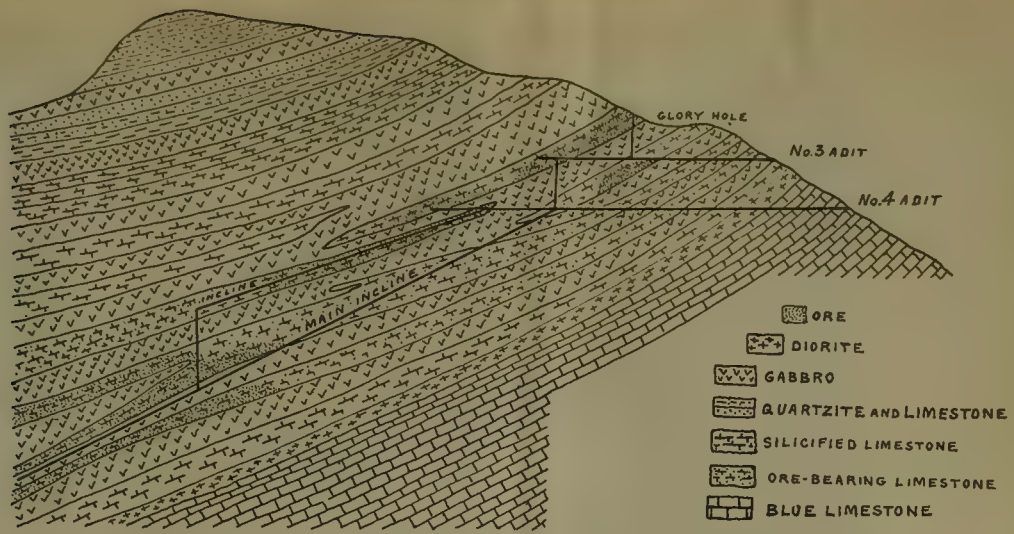
The ore-zone is crossed by a broad band of fracture—50 ft. wide and brecciated—which does not displace the orebodies. It was formerly called Jones's fault—the only one I detected in that worthy gentleman—who informs me that ore is found on both sides, so that this structure is probably post-mineral and is merely an unwelcome intrusion.

R. B. Lamb was manager during 1905 and 1906; he was succeeded by Frank A. Ross, who directed operations for three years, from 1906 to 1909, when Mr. Jones took charge.

The mill is not less interesting than the mine. The first reduction plant was started in 1902. It consisted of 40 stamps, 24 vanners, and a cyanide annex. In this plant 30% of the gold-saving was effected by amalgamation, 29% by cyanidation of the tailing, and 30% in a concentrate that was shipped to Tacoma. In November 1910 several changes were made in the mill, the chief of these being the discarding of amalgamation, because the proportion of gold recovered on the plates declined to as little as 2% of the total yield, owing to a decrease in the proportion of oxidized ore and a corresponding increase in the amount of arseno-pyrite associated with the gold. At that time the mill recovered $43,000 worth of gold from 3900 tons of ore per month.

The drop of the stamps was increased from 6 to 7½ inches, and the speed from 90 to 106 drops per minute. The screen was changed gradually from 24-mesh to 10-mesh. This enlarged the capacity of the plant from 138 to 200 tons per day. The production of concentrate increased from 156 tons assaying $172 per ton to the present monthly output of 600 tons averaging $75. To obtain this result, the concentrating machinery was augmented by 12 Deister tables and the addition of two tube-mills, each 5 by 22 ft., of Allis-Chalmers make, fitted with the Montana-Tonopah lining, and using Danish pebbles. Owing to the increasing quantity of arseno-pyrite in the ore, further changes are being made. Three more tube-mills are to be added, besides 11 cyanide vats equipped with the Devereux agitator; the intention being to subject all the mill-pulp to cyanidation—not the tailing only, as heretofore. The reason for this change of practice is to be found in the high freight-rate to the smelter. Hence the aim is to make less concentrate, extracting as much of the gold as possible in the mill, thereby limiting the outgoing shipments to bullion. This is to be effected by re-grinding the pyritic constituent of the ore so that the cyanide can dissolve the fine gold intimately associated with it. The pulp will be ground to pass 200-mesh; that is, everything will be slimed. Each tube-mill treats 50 tons in closed circuit, reducing ore passing through a screen with a square opening of $\frac{7}{16}$ inch so that 90% of it passes through 300-mesh. At Tacoma the arsenic is extracted from the mispickel as arsenious oxide, or 'white arsenic,' the price of which is 6½ cents per pound at New York.

The most interesting feature of the cyanide plant is the use of the Devereux agitator. Roscoe Wheeler, the mill superintendent, inserted the first of these agitators in February 1916. The agitator consists of a shaft at the lower end of which is a boat's screw-propeller 4 ft. in diameter, having blades 12 inches wide at their widest and having a 'hub' of 9 inches. At 100 r.p.m. the agi-



LONGITUDINAL SECTION OF THE NICKEL PLATE ORE-CHANNEL.

tator consumes 10 hp. in two operations of 12 hours each, separated by an interval of 24 to 30 hours during which decantation proceeds.

The question of power consumption is crucial, I am well aware. Mr. Wheeler's statement may be accepted without reserve. The measurements of horse-power were made with an ammeter on the motor by the company's electrician. The specific gravity of the pulp in the vats is 1.25 to 1.50, while the specific gravity of the dry ore is 3.3. The vat in which this is done is 30 ft. diameter by a 9-ft. stave above a cone of 22½% slope and 6 ft. high, so that the over-all or net height is 16 ft. The capacity of the vat is 241 tons of water, the charge being 125 to 150 tons of slime, diluted in the ratio of 2:1, or twice as much solid as water.

When in action the propeller floats, there being no weight on the bearings. There was a little trouble at first owing to the lower ring cutting into the shaft, but this was quickly remedied by inserting a collar underneath. Otherwise these propellers have been working since last February without a hitch or delay of any kind and without expense save for grease and power. The agitation is excellent. In watching the movement of the charge it is seen that the pulp runs radially toward the centre uniformly and rapidly, 'boiling up' about two inches on the side of the vat. If the operation is stopped,

PLAN OF THE NICKEL PLATE OREBODIES.

there is no trouble in re-starting, even after the slime has had a chance to settle for several days. This satisfactory effect is due to the fact that the propeller is set six to seven feet above the apex of the cone. During experimental work, Mr. Wheeler found that the best results were obtainable by using two sets of baffleboards of 2 by 12-in. plank extending diametrically across the tank—one set being about 2 ft. above the propeller and the other set placed across the top of the charge. If baffles are not used, the pulp would surge six to eight feet and render operations impossible by causing settling, for the slime is driven to the outer staves by any rotating motion. No air is used, the equipment is exceedingly simple, and the cost is low—$150 to $200, exclusive of royalty. The actual cost at Hedley for equipping 11 vats, with motor set and shafting, erected and ready to start, was only $9000 including royalty. The inventor of the agitator is W. G. Devereux, manager of the Melones Mining Company, at Melones, California.

The mine is operated in the name of the Yale Mining Co. and the mill by the Daly Reduction Co., both of these being controlled by the Hedley Gold Mining Co. The operating cost is distributed as follows:

Mining and development	$1.82
Transport	0.21
Milling	0.63
Cyanidation	0.52
Shipping and smelting of concentrate	1.40
Refining of bullion	0.01
Diamond drilling	0.06
Mine general expense and taxes	0.17
Mill and office general expense	0.43
Repairs to mill, power-plant, and tramway	0.59
Total	$5.84

Out of the total expenses—$40,629—in July 1916 the sum of $14,514 was paid in wages. The shipment and treatment of the concentrate constitutes a heavy item. The salaries of the manager and treasurer are paid from New York. Taxes include the provincial tax of 2% on the gross value of the ore less treatment and transport. The total cost is about $6 per ton of ore.

In 1915 the production was 74,265 tons yielding $796,591.78 or $10.72 per ton. The total production from June 1904 to December 31, 1915, has been 582,760 tons having an assay-value of $7,181,920, from which $6,633,752 has been extracted. Dividends to date amount to $3,451,951, of which $392,552 was paid in 1915. The capital of the company is $1,500,000, of which $1,200,000 has been issued.

In a report made by Mr. Jones on January 5, 1916, the reserve of ore is estimated at 423,552 tons, worth $4,400,940, or $10.39 per ton.

The disposal of the concentrate costs $15.53 per dry ton, thus:

Freight	$9.75
Smelting	4.68
Loading	1.00
Customs	0.10

The ratio of concentration has increased from 30:1 in 1910 to 12:1 in 1915, so that the proportion of yield in the form of concentrate has increased from 54 to 71%, and the quantity of concentrate from 1548 to 6188 tons.

The concentrate has a specific gravity of 5.53 and it contains

	%
Arsenic	35.4
Iron	27.8
Sulphur	14.6
Antimony	0.05
Insoluble	17.6
Gold	4.63 oz. per ton
Silver	0.42 oz. per ton

The arsenic is present as an arseno-sulphide of iron, for the mineral mispickel contains 46.1% arsenic, 19.6% sulphur, and 34.3% iron.

Among the mines yielding auriferous mispickel, I may cite the La Belliere, in France, which in 1910 produced 84,784 short tons yielding 38,783 oz. gold and 5211 oz. silver, together worth $854,737. The output included $20,000 worth of arsenious acid, obtained from the roasting of the concentrate. The ore, at that time, was being stamped, tube-milled, and concentrated; the concentrate was roasted and cyanided.

A more important analogue is furnished by the Passagem mine of the Ouro Preto company in Brazil. This property has been operated since 1884 under the direction of John Taylor & Sons. In 1910 Arthur J. Bensusan, the manager of the mine, and R. H. Kendall, the metallurgist, each contributed a description of the technical operations.* The geologic conditions are like those at Hedley in so far as the auriferous mispickel occurs in a contact lode marked by such products of metamorphism as garnet, tourmaline, and calcite, besides albite, zircon, and staurolite. The lode is an extreme silicious phase of a granitic apophysis or intrusion between schistose and quartzitic rocks, to which local names, such as itabirite and itacolumite, have been given.

The ore from the mine is discharged upon a grizzly, of 1¾ in. spaces, the fine going to the upper of two stamp-mills, each of 40 stamps, while the coarse is trammed to the rock-breaker of the lower mill. Amalgamation is not employed. From the battery the pulp runs over blanket strakes. Of the total extraction of gold, 5% is collected in the mortars at the monthly clean-up and 50% is obtained on the blankets, which are washed in cement tanks at intervals of 20 minutes by boys "under the supervision of a trustworthy man." The concentrate thus obtained is re-washed on more blankets, yielding a tailing that is cyanided and a concentrate that is again washed on blanket strakes before being washed in bateas by women for the recovery of free gold. The reject from the bateas is mixed with the concentrate and re-washed next day. The whole system is antiquated to an extraordinary degree. Copper-plate amalgamation was tried, but it had to be abandoned on account of the excessive 'flouring' of the mercury. From the blankets, outside the battery, the pulp passes over Frue vanners, of which there are 18 in the upper mill and 16 in the lower. On the distributor of each vanner is a blanket, about six

*Trans. Inst. Min. & Met. (London), Vol. XX, pp. 3-51.

HEDLEY, B. C.
THE VALLEY OF THE
SIMILKAMEEN.
THE
NICKEL PLATE
MILL.

THE
NICKEL PLATE MILL
AND
TRAMWAY.

square feet in area on which three or four tons of rich concentrate is collected each month. The total production of concentrate consists of 350 tons from the vanners and 150 tons of residues from the various washing operations. All of this averages 22 dwt. gold per ton. In the cyanide annex the concentrate is washed with lime, cyanided in a 0.2% solution, and the gold precipitated on zinc in the usual way. The ore averages 7.25 dwt. per ton. From 6000 tons, a month's output, the yield of concentrate is 156 tons, assaying 8 to 9.65 oz. per ton. The amount of free gold retained per blanket is 4½ to 7½ grains only. The tailing from the vanners undergoes separate cyanide treatment in the usual way. On a 7.25 dwt. ore the total extraction is stated to be 92.5%, of which 54% is free gold, saved in the mortars and on the blankets. The cost of crushing and concentrating is 87 cents and of cyanidation 35 cents per ton.

According to the report for 1915 the total extraction, on 85,400 metric tons averaging 7 dwt. 7 gr. per ton, was 91.41%, distributed as follows:

	Quantity tons	Assay gr.	Extraction %	Gold oz.
Concentrate	6,736	43.85	88.71	8,427.75
Sand	63,206	1.423	69.22	2,000.21
Slime	11,630	3.172	81.96	972.42

Thus the total gold extracted by cyanidation was 11,400.38 oz.; and as the total yield was 28,533.75 oz., it appears that free gold to the amount of 17,133.37 oz. was obtained in the mortars and on the blankets. The report states also that 1398 men were employed on a daily average; of these 141 were in the mill and 28 in the cyanide annex. Obviously this method of treatment would not be suitable at Hedley, where the cost of labor would not permit the manipulation incidental to concentration by blankets, nor is the gold in the Nickel Plate coarse enough to render such a method effective.

At the famous St. John del Rey mine, in Brazil, a similar gold ore was stamp-milled, with amalgamation and concentration, the concentrate being re-ground with mercury in barrels, and the loss of mercury was 12 to 13 ounces per ton of ore. At Pestarena, in Italy, an arsenical gold ore was ground and amalgamated in arrastras. There, as elsewhere, cyanidation replaced amalgamation for the extraction of the gold in the concentrate. At Deloro, in Canada, bromo-cyanide was applied by John Rothwell to a heavily arsenical gold-bearing pyrite. Thus the Nickel Plate is following the usual evolution of practice. Whether bromo-cyanide has been tried at Hedley, I do not know. It remains to add that the recovery of the arsenic on the spot is being considered.

The usual process of recovering arsenic consists of roasting at an gentle heat (less than 1200°F.), in order to expel the arsenic in the form of the oxide, As_2O_3, which is then collected in chambers or flues, yielding a sublimate that has to be purified. It is estimated that from a yearly output of 8000 tons of ore, containing 30% arsenious oxide, a yield of 4,000,000 lb. of arsenic at 3½c. per pound would give $140,000. The cost would include roasting, $3 per ton; barreling, 50c. per barrel; freight, 0.75c. per pound, and selling commission, 1% of the value, making a total cost of $8.20 per ton of arsenic. The cyanidation of the gold-bearing residue, after roasting for arsenic, would cost $2 per ton.

At the present time the total extraction at Hedley is 88%, of which 70 to 75% is by concentration, so that it is evident that cyanidation plays a minor part. The position is to be reversed. The idea now is to slime everything, treat with cyanide, return the tailing over vanners and either cyanide the re-ground concentrate or ship it to the smelter, in proportion to the lowering of the freight-rate by the railway company. Tests have been made, using 10 stamps, or a quarter of the mill. These tests have yielded an 86% recovery by direct cyanidation and 9% more in a marketable concentrate. Formerly the concentrate assayed 4 to 6 ounces in gold per ton; now, after cyanidation, the assay has declined to about $25 per ton. The concentration used to be in the ratio of 10:1 on 600 tons of concentrate monthly; now the shipments will be from 100 to 125 tons only.

The plan of treatment now to be adopted may be sketched thus: crushers, 40 stamps, spitzkasten, the coarse going to eight corrugated-belt vanners, the tailing from which is returned to two tube-mills. The fine from the stamps and the tube-mills is delivered to 12 Deister tables and 16 smooth-belt vanners, the tailing from which is re-classified by four cones, the spigot-discharge being further classified in cones with upward flow of water. The slime from both sets of cones goes to one set of cyanide vats and the sand to another set.

The treatment of the residue for the further extraction of the gold and for the recovery of the arsenic depends upon the freight and smelter rates to be obtained. Like the tariff, metallurgy is a local question.

ALUMINUM DUST. In the November issue of the *Bulletin* of the Canadian Mining Institute, R. B. Watson says: Before the War, aluminum dust cost 33.82c. and caustic soda 2.11c. per pound, laid down at the mine. At the expiration of our contract for aluminum dust in May, 1916, the lowest price at which dust could be bought was 90c. per lb. and caustic soda had risen to 5.77c. per lb. At these prices, the increased cost for these two chemicals would have amounted to about $33,000 per year. This was excessive and necessitated the finding of a substitute immediately. The utilization of sodium sulphide as a precipitant appeared to present the most promising solution of the difficulty, and the experiments carried out by J. J. Denny, in charge of the Company's research department, were so satisfactory, that in June, 1916, the process was adopted for the precipitation of all the mill solutions. It would appear, that even when prices of all chemicals used return to normal, sodium sulphide precipitation will be cheaper than the method formerly employed.

TIN is now stated to be the principal mineral export of Bolivia, having exceeded silver in 1915. The output of tin in that year was 36,492 tons, valued at $16,300,000.

Conservation of Resources

By W. L. Saunders

*The question is, shall legislation be urged before Congress to permit co-operative agreements under Federal supervision in certain primary natural resources, such as timber, the ores and deposits of useful metals and the deposits of minerals which are a source of heat, light, and power. The chief reasons why we seek an affirmative answer to this question are, that through co-operation the basic natural resources of the United States will be conserved; that human life, among persons engaged in those industries, will be better cared for, and that the safety, welfare, and prosperity of our people now and in future generations will be increased.

Remember that we are dealing in this matter only with primary natural resources and that we propose to permit co-operation only under Government supervision and regulation. What are the primary natural resources? Concretely they are forests, natural gas and oil deposits, coal, iron ore, and metalliferous ores, but speaking in general terms these things are the sinews of natural security and prosperity in peace and war.

We are an industrial, not an agricultural nation. It is because we have advanced from the farm to the workshop that we have grown great and rich. Our fathers developed these fields through the cultivation of the soil. Through their labors America sustained human life throughout the world, but Nature has provided us with something more than surface fields for cultivation. We have found other resources and through the development of these resources we have become the largest industrial factor in the world. Just as the farm sustains human life so does the mine sustain industrial life. Human capacity to produce through manual labor in the field is limited to a little more than human capacity to live. A big agricultural country does not grow rich and powerful. It does not build up large cities, but it goes on through the even tenor of its way in perpetual desuetude. Not so with a country rich in mines and minerals. Look at Pittsburg, look at Sheffield and Birmingham, and the distinction is apparent.

There are three great industrial nations in the world: The United States, England, and Germany. Belgium, before the War, was great in industry, though limited in size. Russia and China are great in territory and in wealth, but they do not figure industrially as the world is measured, either because of lack of development or through limitations of raw material. The true measure of an industrial nation is its consumption of coal. A nation might produce a large volume of coal and iron ore, but unless it utilizes this production in industry it does not become great in industry. The United States consumes about 5 tons of coal per capita per annum, England and Germany each consume about 4 tons, while the consumption in France is a little more than 1½ tons, and in Russia about ¼ of a ton. We consume about 16 pounds of copper per capita per annum, while in Asia, for instance, this consumption on the entire continent is only a fraction of a pound. Asia is in the position the world was centuries ago, but even Asia may grow industrially, and if so it will be necessary to draw upon the primary resources of the world and mainly of America.

Let us see what is involved in the consumption of coal, oil, and ores through industry.

During the past 25 years the population in the United States has increased about 70%, while the important basic industries have been enlarged at a rate of increase between 500 and 600%. The entire world 100 years ago only produced about 3000 tons of copper per annum. The United States alone today produces over 600,000 tons. The world 100 years ago produced only about 50,000,000 tons of coal per annum. The United States alone now produces over 500,000,000 tons. How long can this last and what will happen when exhaustion takes place? America is the largest producer in most of these things. We export more than half of our copper. The first result of partial exhaustion will be increased price. This, of course, will restrain industry. It will also restrain our ability to defend ourselves in war, for every one knows that the supremacy of a nation in war today depends upon its strength and capacity in oil, coal, iron, and metals. Plenty of soldiers and even plenty of money are not sufficient to resist attack. A nation might be rendered powerless against a smaller country through lack of industrial strength. The real reason why an impasse apparently now exists in the war in Europe is because in industrial strength the Allies and the Central Powers are about equal.

It may be taken for granted, I think, that every one would agree that our primary natural resources should be conserved. The only element of doubt in the matter would be as to how to conserve them. There are many ways of doing this, but as in all big movements the first step leading to results is for people to get together. Concentration and co-operation are our first remedies. As Dr. Van Hise has said: "Through concentration we may have the economic advantages coming from magnitude of operations. Through co-operation we may limit the wastes of the competitive system."

Take coal, for instance; the late Dr. Holmes of the Bureau of Mines has pointed out that the strenuous competition and low price at which coal was produced made it impossible for the operators in certain portions

*An address before the Chamber of Commerce of Pittsburg on January 2.

of the country to mine the maximum amount of coal from the seams that they worked. In their competitive struggle to maintain a place and to keep out of bankruptcy they were obliged to mine only the easy places in the seam, leaving the rest in the ground to be perhaps never utilized. Dr. Holmes is on record as saying that 40% of the coal is wasted in this way. In all probability this wasted coal can never be recovered, even at increased cost, owing to physical conditions.

Federal experts in the Forest service have pointed out that in the lumber industry practically the same conditions exist as in the coal industry. The best timber only is taken, leaving other grades to decay and to afford fuel for forest fires.

In petroleum and natural gas a criminal waste is going on. A paper read at the recent meeting of the American Mining Congress showed that at the present rate of consumption of petroleum all the known reserve resources of the United States will be exhausted in some 30 years. The author of this paper graphically calls attention to this subject as follows:

"I have seen millions of cubic feet of natural gas wasting in the air—gas so rich in gasoline that it dripped from the trees like an April shower. It has been testified before the Corporation Commission of Oklahoma that ordinary methods leave from 25 to 85% of the oil in the ground. The State Mineralogist of California estimates the loss by evaporation of oil as 25%."

In a hearing before the Senate Committee on Public Lands it is shown that the companies which exploited the famous Glen pool of Oklahoma spent over $11,000,000 in drilling wells when if the whole pool had been exploited by one producer who would have handled the work properly all the oil could have been obtained for a little over $3,000,000.

Farm products and forests go through a process of perpetual renewal, but the mineral resources of the world cannot be renewed and are absolutely limited. No mine has a lease of life in perpetuity. These valuable things are laid on a thin crust of the earth's surface. Let us, therefore, get together and under Government supervision, and perhaps control, we should secure freedom for fair competition, elimination of unfair practices, conservation of our natural resources, fair wages, and reasonable prices. The anti-trust laws were never designed to act contrary to the public welfare. These laws have been framed to prevent abuse, to conserve the public interest, to prevent private monopoly. The Supreme Court has read into the Sherman Act the rule of reason. Let Congress go further and apply the rule of reason to these primary natural resources by exempting them absolutely and entirely from the provisions of the anti-trust acts, putting these resources aside as great national assets, and through the Federal Trade Commission, or some other Government agency, permitting or even enforcing concentration and co-operation so that the present wild and untamed rush to make money while the sun shines will give place to safety first, looking next at fair profits, fair wages, fair play, and the permanent and increasing prosperity of the whole people.

Gold and Silver Production

The Bureau of the Mint and the U. S. Geological Survey have issued the following joint statement as to the preliminary estimate of the production of gold and silver in the United States during the calendar year 1916. Final figures may show increases especially for silver in some States over the estimates made to the Mint, as the mining industry is generally known to have made large increases in the output of silver-bearing ores in many States.

State or Territory	Gold Fine ounces	Value	Silver Fine ounces
Alabama	339	$ 7,000	.....
Alaska	785,721	16,242,300	1,426,300
Arizona	211,805	4,378,400	6,711,800
California	1,069,586	22,110,300	1,937,300
Colorado	919,565	19,009,100	7,771,500
Georgia	977	20,200	100
Idaho	47,006	971,700	10,504,100
Michigan	.....	.....	572,600
Missouri	.....	.....	52,000
Montana	221,335	4,575,400	14,751,000
Nevada	407,714	8,428,200	12,784,600
New Hampshire	.....	.....	300
New Mexico	67,870	1,403,000	2,000,000
North Carolina	1,437	29,700	400
Oklahoma	.....	.....	400
Oregon	91,990	1,901,600	163,800
South Carolina	15	300	.....
South Dakota	363,403	7,512,200	212,800
Tennessee	290	6,000	103,400
Texas	24	500	689,500
Utah	173,831	3,593,400	12,965,700
Vermont	24	500	2,000
Virginia	39	800	4,900
Washington	23,791	491,800	206,200
Wyoming	4,054	83,800	4,700
Philippine Islands	74,962	1,549,600	17,900
Porto Rico	29	600	500
Total	4,465,807	92,316,400	72,883,800
Value at average New York commercial price of silver of $0.658			$47,957,540

These figures compare with the production of 1915: $101,035,700 in gold, and 74,961,075 fine ounces of silver, valued at $37,397,300, which is a decrease in the gold production of $8,719,300, and a decrease in the silver production of 2,077,275 fine ounces, but an increase in silver value of over $10,560,000.

SMELTING is largely a chemical operation, though often not a simple one. Usually slag that is allowed to cool in a pot exhibits crystalline structure, the development of crystallization being more complete in the centre of the mass and gradually becoming less crystalline toward the side of the vessel until at the rim it may be without visible crystals. The same phenomenon is evident in many dikes, the centre showing porphyritic structure, whereas the portions adjacent to and near the walls are dense and devoid of visible phenocrysts. This is due, as in the slag-pot, to the more rapid cooling of the outer portions, while the centre, retaining the heat longer, has time to crystallize more thoroughly.

Government Aid to Alaskan Mining

By John A. Davis

Fuel. *The question of cheaper fuel stands out above all other conditions affecting the Fairbanks district. In solving this problem the Bureau will do more perhaps than in any other way to help the industry at the present time. The utilization of low-grade ores on any sort of scale is impossible under existing conditions; and even in placer mining, upon which this portion of Alaska has been dependent in the past, a point has been reached where the cream has been skimmed from most of the bonanza placers, with consequent appreciable slowing up of this industry. At present the cost of wood, the only available fuel, is from $12 to $16 per cord, and it requires two cords of wood to equal one ton of coal. Thirty dollars per ton for fuel is, of course, prohibitive, except for the richest alluvium. The cost of fuel is a larger item of mining cost here than elsewhere, because the power used in hoisting and pumping is of minor consideration compared with the steam required for thawing frozen ground. I am informed that it is hoped to have the railroad completed from Fairbanks as far as Nenana by January 1, 1918, so that the Nenana lignite can be placed on the market at that time. Such coal, making due allowance for the cost of mining and its preparation for use, should not cost more than $6.50 to $7.50 per ton, delivered at Fairbanks. Fuel at this price will make it possible to work a large area of placer ground that cannot be touched at present as well as to open up a number of promising lode properties.

This fuel, however, is a lignite, comparable with the lignites of North Dakota, none too good and containing a high percentage of moisture, making it inadvisable to use it in the raw state. Our first problem would be to study and advise the best methods for preparing it for market. In the States, and especially in North Dakota, this question has received a great deal of study, so that the work of the Bureau can be applied intensively and particularly to the local conditions.

Assistance to Prospectors. Another vital point on which the station can be of service is by helping the man with a small mine or prospect and a man or company with capital to get together for their mutual good. In general this can be accomplished by obtaining and keeping as complete a record as possible of the mines and prospects brought to our notice and by making this information available to persons and companies interested in exploratory work. To accomplish this I suggest the use of a system similar to that employed at the Denver station, making a qualitative determination of specimens brought to our notice in return for facts and data as to the occurrence, location, quantity, etc., of the ore from which the specimen is taken. Such information would be kept on file, and wherever possible checked up by the mining engineer on his field trips, so that ultimately we should have an accurate record of mining possibilities. By tabulating this information it could be rendered available on short notice.

As an example of the value of such work I may mention the fact that the high price for tungsten ore during the past year induced one of the miners near Fairbanks to mine and ship a considerable amount of such ore to Seattle by parcel post. Unfortunately he did not receive news of the attractive market in time for the ore to reach Seattle before the market dropped so greatly as to wipe out any profit he might have made on the transaction. If he could have had the news only a few weeks sooner (and it is this sort of service I would propose to give) he could have shipped his ore in time to take advantage of the high market.

Or, again, the cost of sending an engineer into Alaska from the outside is too great except for well developed and promising prospects, while the work of the Bureau as just outlined would to some extent take the place of a preliminary examination and furnish data that would justify the trip of an engineer, whereas otherwise it would not be worth while, thus promoting the best interests of all concerned.

Mineral Collections. But even more important than this is a complete collection of specimens of the ores known to be or likely to be found in Alaska, and rendering it available for study by anyone interested. Prospecting has been confined largely to the search for gold. In consequence, a majority of the prospectors are unacquainted with the appearance of many other important economic minerals, nor is there any adequate mineral collection available to them for study. By placing such a collection at their disposal, men would be enabled to learn the appearance and value of other minerals than gold, so that they would not overlook them in the field. But more important still, such a collection would tend to get these men intimately acquainted with the work of the station, as well as in the habit of dropping around when in town. To make our office a clearing-house for Alaskan mining facts and news will be a strong factor in securing their co-operation. The importance of all this should not be under-estimated, because I do not see how our work can have its full value to the mining industry of Alaska unless it has just such co-operation from these very men on whom, in the last analysis, depends the good that the Bureau can do. As a part of the plan, it would be necessary to supplement this collection with information covering the market-value of the ores of the various minerals and, as far as possible, the names of men or

*Abstract of a report made for the U. S. Bureau of Mines.

firms interested in their purchase and also their post-office address.

Lode Ores. Provision will also be necessary for experimental work on lode ores, especially gold-quartz. Owing to the present cost of mining, the lode mines in the vicinity of Fairbanks have not received their due share of attention, but with a supply of cheaper fuel this type of mining should come rapidly into prominence and will offer a field for instructive experimental work. During my stay at Fairbanks I had an opportunity to visit some of the quartz properties, and although these are prospects only, nevertheless this district holds some interesting possibilities when economic conditions are improved. To this end we should be equipped to make necessary tests to determine the best method of treating the ores. We need a small experimental laboratory equipped with crushing and grinding machinery and various machines for concentrating ore. This should be on a scale large enough to give the tests a practical value and yet small enough not to involve heavy expense or a large tonnage of ore.

Placer Deposits. The question of thawing frozen ground also merits attention. The cost of thawing by steam should be studied, as there seems a chance that this can be done more economically than at present. The placer workings are at a critical stage in that most of the bonanza properties have probably been discovered and the future of this industry now depends upon the exploitation of poorer gravel. The Bureau can be of service in suggesting methods for increasing efficiency, saving waste, and lowering cost. The placer deposits require study, not only with the view to saving the fine gold, but also in the conservation and utilization of tin, platinum, and other associated metals. Where stream gradients are low, dredging and other mechanical means of digging the gravel should be studied.

Minerals Other Than Gold. There are many known deposits of uncommon minerals in Alaska, such as antimony, tin, tungsten, molybdenum, and asbestos, which are not now being utilized. The building of the railroad will aid such exploitation, and the Bureau should make a systematic study of these deposits so that when the railroad arrives the miners can have the information to encourage them in mining these minerals.

Bauxite added to refractory clay is said to increase the refractoriness of bricks made of the mixture. Bauxite is added to clay to the extent of 56 and 77% of the mixture. Bricks containing the lower percentage of bauxite are extremely refractory, standing very high temperature. The bricks of higher bauxite content are used as a substitute for magnesite bricks, in open-hearth furnaces.

Iron-ore shipments on the Great Lakes during the past season amounted to 63,648,298 tons, compared with 46,318,804 tons in 1915. The season covered six full and two part months, August being the record with 9,850,140 tons.

Copper Replaces Aluminum

Aluminum transmission-lines have in several instances been replaced by copper wire during the past two years, the latest being 60 miles of line between the Madison River power-plant of the Montana Power Co. and Butte. The wire was in use for 15 years. The general manager of the power company, F. M. Kerr, states that the following reasons caused it to adopt copper instead of aluminum for long-distance transmission-lines: "(1) Aluminum is softer and weaker and particularly susceptible to abrasions at points of support. (2) Aluminum has a low melting-point and is easily burned in two and destroyed by arcs. (3) Where the wires are supported on suspension insulators, side swinging to the wind must be considered. Aluminum is at a great disadvantage in this respect, and on account of its light weight and large area, will swing up into close proximity to the cross-arms, cutting down the necessary clearance to a dangerous extent. (4) Fire hazard and danger to human life are greater with aluminum on account of its liability to burn in two, drop to the ground and set fire to whatever it touches. The ends of the wire will burn free from the ground and hang down as a menace to life." The statement made that the aluminum lines had been adjudged a failure is not entirely correct, according to Mr. Kerr, who says: "We realize and admit that a successful line can be constructed of aluminum, but as before stated, our experience and observations have placed us on record as favoring copper. While the scrap value of aluminum at this time is high, this fact had little to do with our decision. We were well satisfied that the aluminum lines would have to be abandoned within a year or two in any event, and the only effect the high price had was to hasten this work a little."

The term asbestos, as commonly used, includes half a dozen minerals all having a well-developed fibrous structure, but differing in chemical composition and in some of their physical properties. In its strict application the name is limited to the fibrous varieties of the monoclinic amphiboles. Commercially, however, the most important of the asbestiform minerals is chrysotile, a fibrous variety of serpentine. About 95% of the asbestos used in manufacturing is chrysotile, and it commands a much higher price than any of the other fibrous minerals now on the market. The commercial value of asbestos and the uses to which the different varieties may be put are dependent upon the physical properties; fineness, length and flexibility of fibre, tensile strength, and heat and acid-resisting properties. All of the different varieties of asbestos may be split up into exceedingly fine fibres, and when the finest obtainable fibres, having a diameter of 0.002 mm. or less, are examined under the microscope, they are usually seen to be made up of still smaller fibres. The number and fineness of the smallest fibres distinguishable under the microscope increase with every increase in the power of magnification, and there is no apparent limit to this subdivision.

The Chemistry of Manganese

By M. L. Hartmann

*Oxides of manganese have been known from earliest times. The ancient Egyptians and Romans used pyrolusite (MnO_2) for bleaching glass, although they confounded it with magnetic iron oxide.

A mere enumeration of the chemical compounds of manganese would fill many pages. Because the valence of manganese may be any value from two to seven, and because it acts either as a base or enters into acid radicals, its chemistry is complex. In a great many of the reactions in which manganese enters, its function seems to be that of a carrier of oxygen. This is of course due to its easy valence changes. Thus for example, in the production of oxygen by heating potassium chlorate and manganese dioxide, it is thought that the manganese acts as a carrier or intermediary for the oxygen. Again, the function of manganese in the soil in its effect upon vegetation seems to be to bring oxygen to the plant roots. This is especially noticeable in the legumes, where the nitrifying bacteria unite the oxygen and nitrogen. Manganese is found in all animals and plants, and is probably intimately related to the life processes involving oxidation. Only the compounds of commercial importance will be considered here.

Commercially, manganese compounds are important as oxidizing agents and as coloring materials. For oxidizing purposes, manganese dioxide is the only oxide which can be used. This oxide readily gives up one-half of its oxygen. It may be either natural (pyrolusite) or artificial, but practically it must contain from 13 to 17% available oxygen. By available oxygen is meant the oxygen which is readily given up for oxidizing purposes. Manganates and permanganates are used to a limited extent as oxidizing agents.

Bertholett, about 1785, introduced the use of chlorine into the arts as a bleaching agent, and much pyrolusite was used in the process for making chlorine. The Weldon process was invented in 1867 to accomplish the same purpose somewhat more cheaply. This process is largely used today. The mother liquors from crystallization of ordinary salt frequently contain some bromides. Bromine is liberated from these by treatment with sulphuric acid and manganese dioxide, and is condensed and collected. This is one of the chief sources of bromine.

In certain processes where small quantities of oxygen are occasionally wanted, the method of heating potassium chlorate and manganese dioxide is still used. In this reaction, the manganese dioxide acts as a catalytic agent, being itself not changed during the process. This process has been almost entirely replaced by the electrolytic process and the liquid-air process, which supply the market with oxygen of all grades in steel cylinders under high pressure.

On account of the readiness with which manganates and permanganates give up their oxygen, these manganese compounds are used as disinfectants and oxidizers. They also find considerable use in medicine. The use of potassium permanganate as an antidote for rattlesnake poisoning is of interest. The wound is cut open, forced to bleed freely, and the crystals of permanganate generously applied to the cut.

Manganese dioxide is used as a dryer in linseed oil in paints and varnishes.

An important use for high-grade manganese dioxide is in the manufacture of dry batteries. In the ordinary dry cell, the current is produced by the dissolving of the zinc and the liberation of hydrogen on the carbon electrode. If a current is taken from a dry battery for any length of time, the hydrogen bubbles cover the carbon pole so effectively that the current is much weakened. In practice, the carbon is surrounded by a mixture of granulated carbon and manganese dioxide, producing water and stopping 'polarization.' It is essential to have the purest manganese dioxide for this purpose, as impurities set up local circuits which shorten the life of the battery.

In dyeing and calico printing, 'manganese brown' (which consists of the hydroxide or oxide) is used.

The use of manganese in the brick industry has become extensive because of the increased demand for fancy-colored bricks in architecture.

In the manufacture of glass, the materials used nearly always contain iron. In the melting-process the iron is reduced to the ferrous condition, and gives a green color to the glass. This is why cheap glass is green. To neutralize this effect, manganese dioxide in small quantities is added to the glass, producing just enough purple color to neutralize the green, thus giving colorless glass. Colorless glass, when it is exposed to bright sunlight for some time, usually takes on a violet color.

Some manganese ores such as wad are used in the crude state in chocolate and brown paints. 'Manganese green' is barium manganate.

Manganese sulphate is sometimes used in fertilizers.

There are other minor uses for manganese compounds. These include their uses in chemical laboratories; in making soap; in dyeing, as a mordant for certain dyes; in staining wood a deep brown.

In minerals and similar materials, manganese is easily detected by a borax-bead test. In the oxidizing flame, the borax bead containing manganese is amethyst, while in the reducing flame it is colorless. Only a little manganese gives this color; too much makes the bead black.

*Abstract from 'Manganese Number' of the *Pahasapa Quarterly*, South Dakota School of Mines, Rapid City, S. D.

Other substances which give colored beads with borax may interfere with the test. The sodium carbonate bead in the oxidizing flame gives a green color when hot and bluish green when cold. Other substances are not likely to interfere.

In the wet way, manganese compounds may be easily detected by boiling the substance with nitric acid and sodium bismuthate ($NaBiO_3$) or bismuth peroxide (Bi_2O_4), which produces a purple color in the solution (permanganic acid). This test is very delicate, as little as 0.00001 gram in 50 cc. of solution can be detected. Lead peroxide may be substituted for the bismuth compounds, but the test is not so delicate.

Since manganese dioxide is frequently used, and is valuable for its available oxygen rather than for its manganese-content, the available-oxygen determination is frequently made. This is usually accomplished by treating a weighed portion of the ore with hydrochloric acid, driving off the free chlorine that is formed, into a solution of potassium iodide. Free iodine is liberated, and may be titrated with standard reducing solutions.

For the determination of total manganese many volumetric methods have been devised. All of them depend on oxidizing manganese to its highest valence, and then reducing by a standard reducing solution. Certain methods for manganese in steel-works materials have been so well worked out that small 'pills' of the necessary reagents are on the market, with directions reading, "Add one tablet A, allow it to dissolve, and add 1 tablet B," etc., etc. The various methods are described in all books on quantitative analysis, and it would be unnecessary to quote them here.

Metal Price Averages

According to the *Daily Metal Market* the following are averages during the past four years, in cents:

New York—	1913	1914	1915	1916
Straits tin	44.32	35.70	38.66	43.48
Lake copper	15.70	13.61	17.64	28.17
Electrolytic copper	15.52	13.31½	17.47	28.46
Casting copper	15.33	13.18	16.76	26.51
Waterbury copper, average	15.83	13.91	18.94	28.85½
Pig lead	4.40	3.87	4.67½	6.83
Spelter	5.80	5.30	14.44	13.75
Waterbury brass mill spelter, average	6.06½	5.53½	17.50	17.72
Cookson's antimony	8.52	10.50	*24.47½	....
Hallett's antimony	8.07½	9.82	*22.31	....
Chinese and Japanese antimony	7.43	8.53½	29.52	25.33½
Aluminum	23.63	18.59½	33.91	60.73
Silver	59.79½	54.81	49.69	65.66
St. Louis—				
Pig lead	4.26	3.74	4.57	6.80
Spelter	5.61	5.11½	14.16	13.57

*For first four months, no transactions recorded thereafter.

THE Guggenheim and Ryan-Rockefeller groups control three refineries having a present output of 330,000 tons and a prospective output of 360,000 tons of copper per annum.

Volume and Weight of Ore

Quartz in place, in veins, is usually calculated on a basis of 13 cu. ft. to the ton, although it is really somewhat less than this if solid—12.32 cu. ft.—so a small factor of safety is introduced by the employment of the commonly accepted standard of 13 cu. ft. All ore is not solid quartz, however, for it may contain a quantity of sulphide. It is often desirable to estimate the weight of a given volume of ore based upon the exposures in mine workings. In such cases it is necessary to ascertain the relative amount of minerals other than quartz that is present in the ore. Calcium carbonate is a frequent constituent of ores, but as calcite has a specific gravity only slightly less than quartz, its presence would not materially affect the calculation. Take, for example, an ore assaying 20% lead occurring in the form of galena, 25% zinc as sphalerite, and the remainder gangue minerals, principally quartz with some calcite. How many cubic feet of ore of this character, as it stands in the vein will be required to weigh one ton? By the employment of what is called stoichiology, the relative percentage of the various elements entering into the composition of minerals may be figured, using the atomic weights and the valency of the elements, but as *Dana's Mineralogy* gives the percentage of elements forming the most important minerals, a reference to it will simplify the calculation. In that work it will be found that galena (PbS) consists of lead 86.6%; sulphur, 13.4%; sphalerite (ZnS) contains zinc 67%, sulphur 33%. Then, as 400 lb. of lead represents 86.6% of the weight of the galena, the remaining weight—sulphur—is 61.7 lb. Similarly, 500 lb. of zinc constitutes 67% of the blende, there being 246 lb. of sulphur in the blende. We now have in one ton of this ore approximately 462 lb. of galena and 746 lb. of blende, these two minerals aggregating 1208 lb. The balance, 792 lb., is quartz and calcite. A cubic foot of galena (specific gravity 7.5) weighs about 468 lb. Galena present practically 1 cu. ft. A cubic foot of blende (specific gravity 4) weighs 250 lb. Blende present 2.98 cu. ft. One cubic foot of quartz (specific gravity 2.6) weighs approximately 165 lb.; 792 lb. of quartz requires 4.8 cu. ft. of space. These several minerals in the mass then occupy a total of 8.78 cu. ft. for each ton of ore in place.

THE second report of the U. S. Bureau of Mines dealing with accidents at metallurgical works states that at 110 smelters—excluding iron furnaces—and at 560 ore-dressing plants, employing 31,327 and 18,564 men, respectively, there were 38 and 30 killed, and 5718 and 2095 injured in 1915. The number of plants reporting was 92 over the total in 1914, and the accidents were more numerous, as there were 8430 more men at work. The fatalities at smelters was 1.21 per 1000 employed, an increase of 0.02, and non-fatal accidents 182.53 per 1000, a decrease of 20.59. The ore-dressing fatalities increased from 1.59 to 1.62 per 1000, and non-fatalities from 96.71 to 112.85 per 1000.

Conditions in Mexico

By Our Mexican Correspondent

The last Carranza decree effecting compulsory mining work reads as follows:

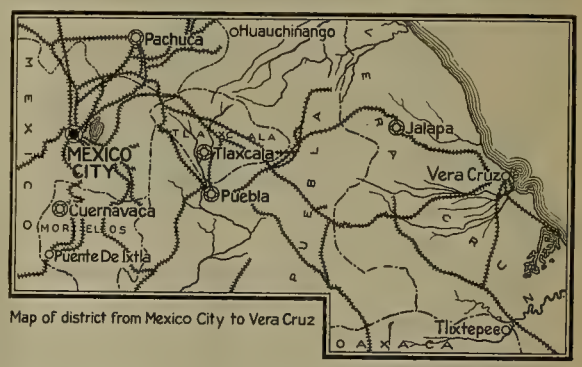
"The First Chief considers that as yet it has not been possible to collect all the data as to the local conditions of each mineral zone; and these data are indispensable for just now the Department of Fomento in enforcing the decree of September 14, 1916, which provides that the idleness of mines can only be allowed to continue when the excuse given by the concessionaire is proper and well proved in the judgment of the Department. Therefore he has seen fit to decree:

Art. I. The excuses which the concessionaires have given will be assumed as proved; and, in order to comply with Art. II of the said decree, they will be allowed a further time, not beyond three months, in which to start up their mines.

Art. II. Only in the case where the concessionaire proves the existence of a reason which renders quite impossible the exploitation of the mines will the time fixed in Art. I be extended, and then only for the period strictly essential.

Art. III. All mining concessionaires, who, before February 14, 1917, have not started up their properties, or have not been able to justify the excuses they give for continued idleness, will lose their rights and the nullity of their concessions will be declared according to Art. I. The Secretary of Fomento, Pastor Rouaix."

As stated in my letter, published in the issue of October 21, it was impossible for 90% of Mexican mines to comply with the decree of September 14; but in accordance with his usual practice Carranza first made the decree, and did not discover that it was physically impossible to enforce it until some weeks later. Nothing is surer than that Carranza is not half as anxious to get the mines started as are their owners; and if most of them have been idle for several years it is for sound reasons, and never more so than this year when the operation of most equipped metal mines means large profits. The truth is that the political conditions are little better for mining now than they were a year or two ago. While Obregon's defeat of the Villa armies, in the Leon campaign of 1915, enabled Carranza to get control of the Central railroad north of Aguascalientes to the border, Villistas, Zapatistas, and other rebels still range the back country everywhere, except in Yucatan, northern Sonora, and to the north-east of San Luis Potosi. Again, railroad facilities seem just as lacking as last year; whatever rolling-stock has been released from the northern campaign against Villa has been offset by a year's wear and the wreckage of Zapata's derailments. It is a curious commentary on 'simon-pure' Mexican management that at present, with only a fraction of the equipment and traffic of April 1914 (on which date all American executives were dismissed from the Government railroads) the force of operatives should be 30% more numerous. In order to reduce expenses, now that employees are again to be paid in coin, it is proposed to reduce their number; and the plan to be applied for the elimination of the unfit would delight the heart of the most ardent American spoilsman, for, as officially announced, "it contemplates the retention of only those who have rendered the most service to the Constitutional party." The third reason why many mines will be unable to resume is the impossibility of recruiting a working force, since only a few fortunate centres, like Pachuca, have been able to run continuously enough to maintain their force of miners unimpaired. Since 1912, thousands of mine laborers have been killed in battle or died of their wounds, as little or no hospital equipment accompanies the Mexican armies on campaign. Other thousands have died of pest or famine, while hosts have become professional brigands (or soldiers), and are having too enjoyable a life to ever go back to work until compelled to by the police. Finally, there are no more banking facilities for the safe-keeping or transmission of money for pay-rolls and expenses; while the mules, horses, and burros on which thousands of mines depended for transportation have—where obtainable at all—become so scarce as to cost two to three times as much as in 1912, while their forage is also dearer.



Map of district from Mexico City to Vera Cruz

Luckily for American miners, Pastor Rouaix, the Minister of Fomento, is one of the most honorable and intelligent of the Carranza leaders, and will probably try to enforce the new decree fairly unless overruled, like Cabrera at Atlantic City, by some "superior political force."

A recent decree changing export taxation is also of interest to miners; it reads: "The first Chief considers that for the return to normality and reconstruction of the country it is proper to facilitate the resumption of suspended national industries and the expansion of ac-

tive enterprises, especially those of mining—so important to the Nation—and has seen fit to decree as follows:

Art. I. From December 10, 1916 till December 31, 1917, the application of the export-tax rates for metals of Art. 10 of the decree of May 1, 1916, will be suspended.

Art. II. During the time of suspension the metals will pay these rates:

Gold and silver, 7% of the assay-value;

Copper in bars, 5% of the metal-value;

Copper minerals, 6% of the metal-value;

Other minerals, 3% of the metal-value.

Art. IV. If the value of copper gets below 20 cents per pound in New York, the rates of 5% for bars and 6% for minerals of Art. II will be reduced to 5% for both.

Art. V. The exception established by Art. II, part G, of the decree of May 1, 1916, will hold only in the following cases:

In minerals of copper when they have less than 5% copper; in those of lead when under 15%; and in those of zinc which hold less than 20% zinc.

Constitution and Reforms—Queretaro, December 8, 1916.

V. Carranza to Sub-Secy. of Hacienda."

This decree is supplemented by the following circular of the Department of Hacienda of the same date:

"To determine the values of exported metals, this department will fix them each month on the base of New York quotations as follows:

Silver and gold: The value will be the New York quotations exactly.

Zinc: The value will be 75% of the assay-returns and will be calculated on the New York price of zinc with a deduction for smelting, taking as base for the latter the average of the market of Saltillo, Mexico, and Tulsa, Oklahoma. For the other metals, the values will be calculated as placed in the frontier or maritime customhouse, with the idea that when lead is exported as bullion there will be taken into account the freight from the frontier to New York and the cost of refining."

The reductions in the last decree are most weighty for the precious and metal mines, and may mean profits instead of losses for many low-grade properties. They will help to offset the increased costs due to revolution and to the sudden restoration of wages to a metallic basis within the last two months. This restoration, which was started by the decree of October 23 (see my letter published in the issue of December 16), involved much loss to employers and many strikes of workmen; the worst of the latter being a strike of all the railroad hands that shut-off every civilian train for 12 days during November. Carranza, when he found his first decrees were unsatisfactory or absurd, resorted to his usual trick of nullifying or changing them till something workable was attained. It may safely be affirmed that no mine-foreman could keep in order a force of even a dozen men if he should deluge them with strange orders every Monday, and then spend the rest of the week retracting or tinkering them. Yet what would ruin a petty foreman is only diversion for a military autocrat; for, as was observed long ago "any fool can govern if he has the bayonets."

As an example of one of these Carranza tinkering decrees, I will give that issued by César Lopez de Lara, Governor of the Federal district, on November 22, 1916:

"Considering I: That employers, on account of the decrees of October 23 and November 17 affecting the payment of wages, have begun to dismiss a large part of their force without just cause and without moral scruples as to the crisis involved for those discharged, because of the present difficulty of finding new work;

Considering II: That the first duty of all governments is to insure that the living of social classes may be achieved without sacrificing one class for another; it is clear that the Government of the Federal District would fail in its primary duty if it did not rush to the rescue of the labor groups and protect them against the maneuvers of capital, which in spite of its profits, every day more outrageous, strives constantly to increase them even at the cost of its clerks and workmen;

Considering III: That, apart from the injustice which unfair dismissals imply, such conduct, when systematically repeated, can seriously disturb that public order which the authorities must preserve at any cost; I have therefore seen fit to decree:

Art. I. Companies, firms, or individuals engaged in serving the public for gain must not dismiss any of their paid help without just cause.

Art. II. The only just causes for dismissal under this decree will be:

(1.) Fraud or abuse of confidence of employer. (2.) Incompetence or wilful neglect by employee. (3.) Absence from paid work to engage in other occupation. And (4.) Serious lack of respect and consideration for their employers or associates.

Art. III. In case of dismissal without just cause, the owner or manager of the guilty business will indemnify the dismissed person by two months advance salary, payable half in coin and half in infalsifiable notes at the ruling rate for the decennial (ten days) prescribed by the Department of Hacienda.

Art. IV. The complaints alleging an infraction of Art. III must be presented before me, for a resolution after a speedy investigation.

Art. V. The indemnities fixed by me in each case must be paid within 24 hours or the neglectful ones will be punished by either a fine of up to ₱500 gold or 15 days in jail, besides paying the indemnity.

Art. VI. All dismissals since December 17 will be judged by this decree."

It is a pity that the Latin-American News Association of New York (*alias* Mexican-American League) does not enlighten its hosts of American Democratic dupes with English copies of this benevolent decree. The fact that Art. VI was retroactive legislation, forbidden by the Constitution, did not worry this gentle Mexican Caesar, but he got so worried by having to carry out Art. IV that, inside of three days, he lost patience and issued another decree to announce that thereafter Art. V would be enforced without investigation of a complaint's merits.

When Oaxaca declared itself a sovereign State in April 1915, it was too weak in troops to expel Carranza from its ports and the Tehuantepec railway, but it held Oaxaca City and the State's mountain districts until March, 1916, when it was invaded by General Villaseñor, the Carranza commandant at Tehuacan, who soon defeated its general, Higinio Aguilar, at Ocotlan. During the three days of this battle, or rather long-range skirmish, Oaxaca City was without a government, and the public buildings were sacked and their judicial archives burned by a mob—but probably not entirely a ragged one. Then General Higinio's troops entered town on their retreat from Ocotlan, and had just begun a systematic loot of private houses when they were luckily put to flight by a woman screaming "the Carranzistas are coming." Finally, when the invaders actually did arrive, a troop of them took advantage of the isolation of the suburb of San Felipe and robbed its beautiful villas.

The epidemic of hunger typhus that had been raging in Oaxaca all winter reached its culmination in May, and is still existent after destroying thousands. The only mine that has operated since April, 1915, is the rich Natividad, the cyanide mill output of which has been one of the mainstays of the State troops. Nevertheless, a dozen or so of American miners may still be met in Oaxaca City, who seem like ghostly reminders of the happier days of yore, when the State was over-run by prospectors and the social club of its capital had some 150 American members.

The history of Gen. Higinio Aguilar, an active old man, may furnish some food for thought to those who believe with Bryan that "every people is quite competent to create its own government without outside interferences." The wily politician may not be so simple in promulgating this dogma as are some of his foolish followers in accepting it; because it is self-evident that any folk can create 'some kind' of a government, while it is historically proved that few peoples have ever established a 'civilized' state. A Federal Officer for Diaz until middle age, Higinio developed independent ambitions, some 8 years ago, and rebelled against the Government with his whole army in the State of Vera Cruz. Then, joining Madero, he helped him in his revolution; but later shifted against him, when president, to the side of the rebel Orozco. Huerta, on his accession to power, enrolled Higinio along with the other anti-Maderistas, but Higinio liked the bossing of Huerta even less than that of Diaz or Madero, and soon moved again into rebel quarters. After Huerta's fall, Higinio, for awhile, acted with Zapata against Carranza, but afterward he resumed his independence until he was hired by the State of Oaxaca early in 1915. During all these kaleidoscopic changes of allegiance from liberal to conservative and back again, Higinio's troops, varying in number from 2000 to 4000, followed him without a murmur. Whomever their trusted chief tells them to fight, he is the enemy! With Higinio they are confident of food and clothes and plenty of diversion, what do they care about political principles? Curiously enough, Higinio is not a common bandit, he rather resembles the German captains of roving mercenaries who plagued Italy in the 12th century. He does not permit robbery or looting as a rule, because he recognizes its interference with his prescribed discipline, and, like the balance of big Mexican chiefs, he has discovered that retail robbery is much less profitable than political exploitation. To obtain necessary funds after his dislodgment from Oaxaca City, Higinio made a deal with his supposed enemy, General Villaseñor, and between them they extracted from the mule caravans between Puebla and the mountains of Oaxaca "all that the traffic would bear." This canny conduct of General Villaseñor finally became too public a scandal for even the indulgent Carranza to longer overlook; so, after some 18 months at Tehuacan, General

SOUTH-WEST TEXAS AND NORTH-EAST MEXICO.

Villaseñor found himself, one day, ordered to the new satrapy of Matamoros, in Puebla..

In early November, General Pablo Gonzales, who had been in possession of Zapata's capital, Cuernavaca, since spring and still found it dangerous to leave the railroad points, decided to "constitutionalize" the whole State of Morelos. Accordingly he issued a decree inaugurating a new trial of the inhuman Weyler plan for re-concentration of rural populations—a scheme that Huerta had tried to start in 1913. But instead of hunting the Zapatistas, Gonzales suddenly found conditions reversed and had to flee for his life back to Mexico City, though his loss of Cuernavaca was never mentioned by the "free" press of that capital. The wherefore of Zapata's military revival was a new stock of cartridges, and thereby hangs a tale. Estrada Cabrera has long been dictator of the republic of Guatemala, and this deplorable anachronism recently attracted the attention of a group of Carranzista enthusiasts who had long been anxious to imitate the French *sans-culottes* by dethroning a 'foreign' despot. Indeed, all the political and economic theories of the present Mexican revolution have been borrowed from France; and if in practice the Mexican imitators have

rarely gone beyond the blunders and crimes of 1789 so as to repeat the wonderful achievements of that unique epoch, they are blissfully quite unaware of it. Securing Carranza's fatherly aid, the crusaders stocked a ship with 240 soldiers and 5000 rifles with ammunition, and set out on their quest for Guatemala. But Don Estrada is no novice at his job, or he would not have survived for 16 years as tyrant of Guatemala, and he discovered the object of the crusaders before any of them had even landed on his private domain. After this, the disposal of these amateur filibusters was as easy as the drowning of trapped rats, but there still remained a score to settle with his erstwhile 'brother' ruler, Don Venustiano. Accordingly, the latter's enemies have since been given every facility for getting munitions *via* Guatemala, whose frontier is only a few days by mule-trail from Zapata territory. The new rising in the State of Chiapas is likewise part of Don Estrada's reprisal. From time to time also Zapata succeeds in landing munitions at one of the many ungarrisoned lesser ports along both coasts of Mexico. Thus, a short time ago he landed a large cargo at Sta. Cruz de Huatulco in Oaxaca, from a ship flying the Japanese flag.

This year there has arisen a new party, the Legalista, which aims to unite all the anti-Carranza elements, such as the Mexican refugees abroad, the Oaxaca State or Felix Diaz faction, and the Zapata government. The Legalista junta established headquarters "somewhere in the United States," and reserved its strength until the re-election of Wilson nullified its hope of a possible change in American policy. Since early November this junta has been active in helping the southern rebels, but whether they have backed Villa in his recent murderous raids on Chihuahua City and Torreon, I have as yet no information. That corn and beans, the staple foods of the poor, are still fairly plentiful and cheap in southern Mexico, three months after harvest, is largely due to the United States embargo on arms, which, if it continues, will save in 1917 the lives of countless Mexicans who would otherwise be crushed as in 1916 by the wheels of Carranza's juggernaut car, the Casa de la Garda. In fact, at present the Government seems to be using this ingenious food collecting and exporting machine for beneficent purposes, since it has recently opened depots in Mexico City where food is being sold to the masses at low rates.

The embargo has been so strict that Carranza could not even get delivery on munitions long ago paid for, until early in December his New York agent smuggled out a million cartridges on a Ward Line steamer, packed as 'hardware.' Even then the trick was discovered by an alert naval officer on an American ship in Vera Cruz harbor, and the unloading was held-up until the usual "orders from Washington" spoiled all the effect of the Navy's vigilance by letting Carranza have his cartridges. In spite of this favor, the Government journalists have lately been calling President Wilson a hypocrite, and urging, as the indispensable minimum for the new peace treaty, not only the expulsion of General Pershing but the prohibition of embargo, so that in future the nation's food can be exported and munitions imported without let or hindrance.

One might think from the figures for trade with the United States during the fiscal year ended June 30, 1916, that Mexico had been unusually prosperous. Exports to the United States were ₱97,000,000 (gold) or ₱28,000,000 ahead of 1915, and ₱20,000,000 more than in 1914 (though behind several years previous), while imports were ₱195,000,000, against ₱155,000,000 in 1915, and ₱185,000,000 in 1914, the previous high years. (These figures do not include the precious metals, whose output and export from Mexico have greatly decreased since 1911.) But one would think wrong, because that part of the increase of United States trade in 1916 which does not merely represent a compulsory transfer of trade formerly conducted with Europe, and a somewhat higher value for henequen and petroleum, means an increased import of war munitions and the ruinous export of Mexico's working capital as well as of its essential food. The effect of the export of food is chronicled in thousands of new graves in every State. The effect of the export of capital such as livestock, can be noticed especially in the North, where one may ride hundreds of miles over the endless pastures without seeing even a horse or a cow.

Up to November 1916 the Federal post-office had been conducted according to the old-fashioned morality, and with a trained force, largely a holder from previous régimes. But this reactionary condition evidently had become irksome to the financial reformers of the Department of Hacienda, which decided to alter matters. The first signs of the reform was a decree—in the middle of November—that faced post-office clients one morning, announcing a 150% increase in rates of postage to begin "at once." Hitherto several days' notice had been given of a change of rates. The same decree announced that infalsifiable notes would no longer be accepted for franking foreign mail (which must henceforth be franked with coin), but that the notes would be good for all domestic mail until January 1, 1917. But six weeks is a long time to wait for coin, even if you have promised to do so voluntarily by a published decree, so why wait? Evidently the 'new' morality prescribes no good reason, for on December 6 every Carranza postmaster received a telegram instructing him to repudiate all the stamps already sold for notes, and to sell in future nothing but coin stamps. The holders of note stamps, some of whom had bought a large quantity, relying on the Government's previous promise of their acceptance till January 1, and tried to exchange them for coin stamps at the official quotation between notes and coin (100 to 1) were simply told "nothing doing."

The intervention of the banks of issue (see my letter published on December 16) began in November to yield rightly to the Department of Hacienda, in the form of a specie loan of $1,000,000 from the National bank. Since that date, the Government has had plenty of specie for all its obligations, but if any of this has been acquired by fresh 'loans,' it has not been mentioned by a prudent press. Having now plenty of coin itself, the Government

is naturally intolerant of any lack of it among civilians, and this condition may justify the somewhat petulant attitude described for Caesar and the Chief Postmaster. On December 15 a second 'Law of Payments' was decreed by the Department of Hacienda, which gives a fairly reasonable table for adjusting unpaid and future real-estate rentals in coin, and establishes a moratorium for all other debts, including those pending in the Courts. This moratorium is to last "only the brief period before the resumption of the Constitutional régime," after which happy event, the new public powers will again tackle the problem caused by the "re-appearance of coin in the markets and the difficulty of its circulation simultaneously with paper money." This last decree appears to close the open season for Mexican creditors, which has been on since 1913, and in which this pestiferous class of game has been hunted to its lairs and largely exterminated. The worst sufferers from this hunt may prove to be bank depositors, for many of the banks were perhaps insolvent even before the Government decided last September to relieve them of further worry as to the custody of their cash reserves. Under the Mexican plan of discount, the time-limit of notes is nominally six months, but the custom has been to renew these notes regularly from year to year. In normal times this system was harmless, but the recent insanity of Government finance has altered matters and forced the banks to accept depreciated paper in payment for millions of their original specie loans. As a part offset to this ruinous depletion of assets, the bankers have been able to buy-up for paper money many of their own bank-bills, legally redeemable in coin. Also, as they have accepted no new ordinary deposits since March 1915, they have made good gains by paying off in paper money all checks and drafts made against their 'old' deposits, mostly made in specie. Finally, some of the more unscrupulous bankers have forced any depositors who were simple enough to be illegally intimidated to withdraw their entire deposits in paper money, the value of which meant only a fraction of the original coin deposited.

For the first 10 days of December, the infalsifiable paper peso was officially quoted as worth 1 centavo in Mexican gold; for the last two periods of 10 days the quotation was 2/3 centavo or 1/30 of the peso's nominal value of 20 centavos when first issued last May, which value was not officially recognized as depreciated as late as the first 'Law of Payments' of September 15. With its recent refusal to accept its infalsifiable paper money in payment for either revenue or postage-stamps, the Government has now practically completed its repudiation; though the paper money is still receivable for certain local taxes at its official quotation. Yet as late as November, the reputable merchants of various cities were accused of abetting the 'reactionaries' in depreciating the paper money; and many were fined, jailed, or even made to perform as public street-sweepers because of refusal to accept it in payment for their goods at the official quotation, always below the market one. Thus in less that eight months Louis Cabrera has issued ₱500,000,000 of infalsifiable notes and not only repudiated them all, but ₱800,000,000 of older Vera Cruz notes besides. This makes a total repudiation of ₱1,300,000,000, a feat of high-binder finance which is probably the world's record for speed since history began. And yet few Mexicans appreciate the enormity of the public swindle or have even any grasp of what has actually happened. At least Cabrera has lost little of his popularity in Government circles; he appears to have a life place as Minister of Hacienda, and few Mexicans have been more fêted by prominent American Democrats.

During the past six years of revolution, Mexico City has never been as unsafe in the streets at night as recently. Many of the footpads when apprehended have proved to belong to the Federal army or secret service, while there are many that ply their trade with the aid of automobiles. It is not unusual for several dozen victims to be brought to the hospitals as the result of a single night's hold-ups. Though many businesses are paralyzed or shut-down entirely, the Capital's trade in luxuries has never been more active, for the Carranzista

A FIELD OF MAGUEY, MEXICO.

chiefs are liberal spenders; golden spurs for the men and clusters of diamonds for the women have become almost *de règle* among the official elite. Nevertheless all successful "liberators" do not care to waste their substance in riotous living, but instead are providing for future rainy days. Some prefer Spain as a future home and are imitating Luis Cabrera, who purchased last spring a million-peso estate near Madrid. Others favor the United States, like Don Venustiano, who is said to have sent out ₱4,000,000 in Mexican coin in the same private car that took his family to Texas in October. A third group, like General Castro, governor of Puebla, less timid than the preceding, expect to continue indefinitely in Mexico and are preparing to found a new landed aristocracy to replace the one now in exile. This group thinks less of the abolition of peonage than it does of the cheapness of the land, which it is rapidly acquiring; some from the intervention commissions, who confiscate the estates of 'reactionaries,' some from the discouraged owners who can't afford to pay the excessive military demands for protection against bandits, and the others because the Carranza prohibition of further real-estate purchases by foreigners has greatly restricted the number of land-buyers and depressed the prices at forced sales.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

RENO, NEVADA

RECENT PROGRESS AT VARIOUS MINING CENTRES.

The new year finds the Ely district in a favorable condition, indications pointing to a largely increased output during 1917, provided copper prices remain satisfactory. Nevada Consolidated is producing upward of 12,000 tons of ore daily, with most of this derived from steam-shovel pits. Four to five cars of silicious carbonate ore are shipped daily to the Garfield, Utah, smelter. Much new work is going on at the mines and plant, preliminary to a heavier yield. The Coppermines Consolidated is doing extensive work from the Morris shaft, and the first 500-ton unit of the re-modeled plant is nearly ready for service. Another 500-ton unit is to be erected shortly. The Callow flotation system is employed.——Control of the Ely Consolidated group has passed into the hands of W. O. Kay, C. W. Geddess, F. H. Vahrenkamp, and the Gobe-Pingree-Eccles interests. Arrangements have been made for extensive work under the management of C. W. Geddess. The Ely Consolidated comprises 400 acres pierced by the Zack, Brilliant, and American shafts. The Zack is 700 ft. deep, and is the main working outlet. The Brilliant has a depth of 625 ft., and the American is down 350 ft. On the 400 and 600-ft. levels of the Brilliant shaft, and the 500 and 600-ft. Zack workings, large bodies of low-grade ore are exposed. Early shipments of the higher-grade ore are anticipated. Tests may be made at the Copperopolis, California, flotation plant of the Calaveras Copper Co. The manager, S. M. Levy, of the latter company is president of the Ely Consolidated.

Copper mining is claiming considerable attention in the Jungo field of Humboldt county. The Craven Copper Co. has developed ore to a depth of 230 ft., the copper occurring in the form of cuprite and copper glance. Machine-drills have been installed and small shipments are being made, the ore averaging $100 per ton. P. H. Craven is manager.——On the Copley property ore of shipping grade is being broken across faces from 2 to 4 ft. wide. Copper predominates, but there is some gold and silver.

Further delay has been experienced by the Goldfield Consolidated company in the placing of its flotation plant in commission, due to severe storms and interruption of electric-power service. All equipment is in position. It is probable that ore from other mines will be treated, particularly the Atlanta and Kewanas. Meanwhile the cyanide plant is treating 1000 tons of low-grade ore per day, yielding monthly net profit of $15,000.——The Jumbo Extension company has assembled a Calyx core-drill on the 1017-ft. station of the Jumbo Extension shaft, preparatory to prospecting the shale-alaskite contact. The quartz fissures extending into the alaskite will be given particular attention. Unless new ore is found, the productive life of the Jumbo Extension mine is nearly ended. The company has taken the Copper Mountain property, in the Rand district, 45 miles east of Luning, under option.

Goodsprings district continues to report substantial progress. Net earnings by mines of the district in 1916 are estimated at fully $4,000,000, of which over $3,000,000 was derived from lead and zinc ores. The remainder came from copper, silver, gold, platinum, and palladium.

Pioche is shipping a large tonnage of zinc, lead, and silver ore and concentrate. The mill of the Consolidated Nevada-Utah Mining Co. is crushing approximately 600 tons of ore daily, and yielding 20 tons of zinc concentrate, and 1 ton of lead concentrate. The Callow system of flotation is employed. The company is preparing to increase the capacity of the mill, and to conduct mine operations along broader lines.——The Hamburg Mines and Uvada companies are contemplating more extensive work, and the Highland Queen has passed into the hands of strong interests.——At Atlanta the Atlanta Home Mining Co. is developing large bodies of low-grade gold-bearing ore, and it is probable that a large mill may be erected next summer. Heavy shipments continue to be made by the Prince Consolidated and Amalgamated Pioche.

The Nevada Douglas Copper Co. is increasing mine operations at its holdings near Ludwig, and it is likely that considerable ore will be shipped to the Thompson smelter as soon as that plant goes into commission. The management contemplates the erection of a 100-ton flotation plant, operating in conjunction with the leaching plant now in service. Approximately 300 men are on the pay-roll.——The Mason Valley Mines Co. has practically completed arrangements for the blowing-in of the first unit of its Thompson smelter. Work has been resumed in the mines. A large number of small copper, gold, and silver-lead mines tributary to Yerington have recently resumed work, in anticipation of shipments to the Thompson plant.

The Willow Creek Gold Mining Co. is planning construction of a mill in the spring. The property is at Willow Creek, between Ely and Tonopah, and has produced some rich ore. A large quantity of milling ore is on the dumps, and a fair quantity blocked-out underground. F. H. Scott is at the mine arranging for further operations.

Two mills, the Elko Prince and Coots, are operating at Gold Circle, and the Esmeralda plant will go into commission shortly. The bullion output is stated to approximate $70,000 monthly, of which the Elko Prince is producing over $35,000.

AUSTIN, TEXAS

THE SULPHUR DEPOSITS OF WESTERN TEXAS BEING EXPLOITED BY DEVELOPMENT COMPANIES.

The fact that several companies of large capital recently acquired holdings in the sulphur district of Culberson county of western Texas, and that development and mining of the mineral deposit is in progress, caused the Bureau of Economic Geology and Technology of the University of Texas, at Austin, to send recently Dr. Emil Bose and Edwin Porch to make an investigation of these sulphur beds. Their preliminary report says:

"Sulphur deposits in West Texas have been known for a long time, the most important are located in Culberson county, near the Rustler hills, from four miles east to twelve miles west of them, and north-west of Toyah from 35 to 65 miles. There are six companies doing prospecting or development work in the district, and with two exceptions, all the work is being done east of Rustler hills and within one to five miles of Maverick Springs. The sulphur occurs as bands, incrustations, and impregnations or disseminated crystals in a brown, porous gypsum; and in a brown, porous firm earthy material; as bands, frequently associated with much crystallized secondary gypsum; in a hard black, gypsiferous, or silicious rock, the bands extending both vertically and laterally; as impregnations or replacements around and in the altered pebbles of what was once probably limestone conglomerate. In one place

the sulphur deposit has some connection with what appears to be a large cave, filled with spring deposits. In many places the sulphur deposits come to the surface, or close to it, but prospecting is difficult, owing to the fact that in most cases, there is nothing on the surface to indicate the presence of the sulphur below. There is no doubt that the Culberson County deposits are widespread and contain considerable sulphur, but they are irregular, varying greatly not only in the vertical and lateral extension of the sulphur-bearing rock, but also in the sulphur content. The deepest shaft noted was 35 ft. This shows some sulphur from top to bottom, so there is a chance of finding more sulphur as greater depth is reached. The district may be considered as still in the prospect stage, and not enough sulphur-bearing rock has been developed to assure the success of the district. Under normal conditions, sulphur is a low-priced commodity, and such large tonnages have to be handled that heavy expenditures for equipment are never justified until the deposits have been thoroughly explored. Other factors to be taken into account are the most efficient method of extracting the sulphur from the rock and the cost of transportation and marketing."

PLATTEVILLE, WISCONSIN

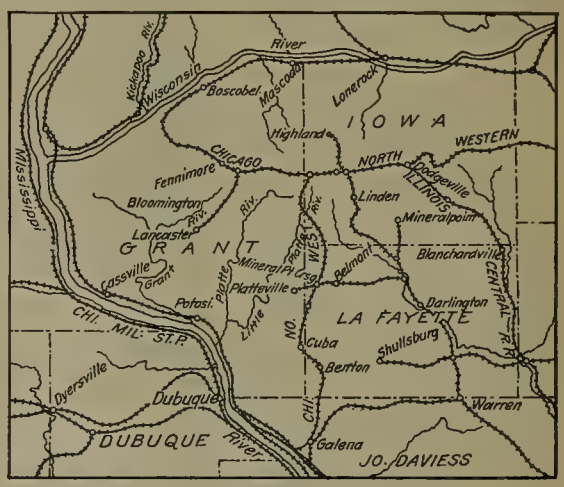
HEAVILY INCREASED OUTPUT FOR DECEMBER.—NEW OPERATIONS.

Operations, in the Wisconsin zinc-lead field, for the concluding month of the year 1916, in spite of serious drawbacks due to inclement weather and bad wagon roads resulted more satisfactorily in a general way than for any one month of the year. It has been observed over a number of successful years that the best showings were made about mid-summer but this year the month of December is entitled to distinction as the banner month. Production in the face of a rapidly declining market, following breaks in the price of spelter, was the highest of any one month of the year, the gross recovery of mine-run product aggregating nearly 50,000,000 lb.; shipments from mines to separating plants, in the field and to smelters direct from mines were the highest recorded by the field in a single month, running 55,510,000 lb.; newly developed mines, with complete modern mining-rigs came into active service at several points; extensive improvements involving the expenditure of $500,000 were brought to a successful issue in connection with the leading electric-power plants supplying the mines with current; the labor demand showed no signs of abatement, skilled labor especially being sought persistently, mill-men, machine-men, foremen, engineers and experienced miners having first call in the recruiting of working forces for new zinc ore producers; exploration work, with drill-rigs, was continued throughout the month, at times under distressful conditions, with numerous rich strikes reported; a scarcity of cars available for prompt loading developed at times which carriers relieved as well and as quickly as possible. At one time eastern roads laid an embargo on zinc ore destined to eastern smelters but prompt and efficient work by leading mine officials brought relief. There was one phase of the industry that marred its peaceful and progressive trend and that was a number of mine fatalities taking an unusually heavy toll in human life. With the exception of one instance, where two were instantly killed, the causes were unavoidable as far as management is concerned. Generous restitution was made to the families of the unfortunate men.

Exceptionally high prices for zinc ore at the beginning of the month was the stimulus to operations at a maximum. Had the opening figures the first ten days of the month been sustained there is no telling what the figures on production and shipments would have reached as premium grades of refinery plants held at $105 per ton, down to $98 per ton base on seconds, and medium grades, down to 50% zinc assays held at $95 per ton. Profits were enormous. The first sharp break following the drop in the metal market came about the middle of the month and the figures receded to $93 for high, and $89 on seconds, and mediums at $83. One week later came another break, worse than the former, the top price receding to $75 per ton base on premium and 60% ore, with the range on seconds and medium going to $70 and $65, respectively. These sudden reversals took the heart out of the independent concerns that were left with an indifferent demand for medium and low-grade ores, which previously had been much sought by representatives of reduction plants operating in the field.

The large operating groups maintained a steady output and the advantage of nearness to the railway enabled them to keep up a steady production, the shipments keeping pace with output. Many independent operators, somewhat removed from the track were at times entirely isolated on account of bad roads, the freezing weather of the first part of the month giving way to rain and sleet, which did much damage to power and milling plants besides making roads impassable. The reserve in the field, while not great, represented the last week's production. This was held and consisted of both the high-grade refinery ore and low-grade concentrate.

The market on lead ore was better sustained throughout the month than that on zinc ore. Prices mounted gradually during November until offerings nearly reached the figures attained by zinc ore. The closing days of the month witnessed



THE WISCONSIN ZINC REGION.

a break in prices as pronounced as it was sudden, the price receding from $95 per ton high, to about $80. Such ore as had been marketed came in the first three weeks of the month under the higher priced bids and when the market declined no ore was offered. The reserve in the field at the close of the month was estimated at about 1000 tons. Pyrite enjoyed a season of exceptional prosperity, the price becoming standard at $7 per ton. Shipments of fines from separating plants did not run as high as had been anticipated. Many mines long abandoned, but capable of producing this class of ore in quantity were re-rigged and put into operation and some crude ore began to find its way to the track before the close of the month. A new outlet for carbonate zinc ore enabled a few miners in the northern districts to make shipments but the quantity of ore marketed was not large.

In the Highland and Mifflin camps two new mills were waiting on developments made to secure an ample water supply for milling. In the Linden district two new mills were put in operation, one for the Spring-Hill Mining Co., capacity 150 tons each 10-hour shift, and the Weigle property for the Pollard-Saxe Co. In the Mineral Point district, the Harris Mining Co.'s old leasehold and equipment was being fitted up for active work. At Platteville the New Rose Mining Co. completed a small plant and was milling before the close of the year. Benton camp has two new producers with equipment,

one for the Wisconsin Zinc Co., on the Longhorn mine, and one for the Frontier Mining Co., on the Bull Moose range. A wet-mill was also being constructed for the Wisconsin Zinc Co. to be operated in connection with the Skinner zinc ore refinery, to eliminate contaminations from refined ores. A large warehouse was also under construction to store supplies for the mines, mills, refineries and boarding-houses operated and maintained by the Wisconsin Zinc Co.

Shipments, by districts, for the month of December were made as here shown:

District	Zinc, lb.	Lead, lb.	Pyrite, lb.
Benton	22,778,000	272,000	.....
Mifflin	6,778,000	74,000	.....
Galena	5,626,000	80,000	.....
Hazel Green	4,284,000	.....	.....
Shullsburg	4,230,000	308,000	.....
Linden	4,012,000	196,000	1,244,000
Cuba City	3,670,000	.....	2,572,000
Platteville	2,060,000	60,000	.....
Highland	1,034,000	60,000	.....
Montfort	424,000	64,000	.....
Potosi	408,000	50,000	.....
Dodgeville	190,000	.....	.....
Mineral Point	16,000	.....	3,036,000
Total	55,510,000	1,164,000	6,852,000

The Mineral Point Zinc Co., running on full time, three shifts daily, with two reduction plants, handled 204 cars of crude ore during the month, 15,320,000 lb., from which was recovered and shipped to smelter at DePue, Ill., also, 94 cars of top-grade blende, 6,928,000 lb. Out of a total of nearly 50,000,000 lb. of mine-run ore, there was recovered and shipped to smelters 28,898,000 lb. of both refinery and high-grade ore. Fifteen buying outlets were afforded zinc-ore producers during the month. Lowering markets near the close eliminated companies that had been active when prices were high and the demand strong and steady. Producers were optimistic regarding the outcome, many claiming that prices would advance after the holiday season as production would decrease with continued winter weather. A reduced output, it was shown, was being made in the Missouri field and that such curtailment would necessarily mean a scarcity of ready ore for smelters. German peace proposals it was held was the determining factor in the market situation and the fact that no definite conclusion had been reached, it was argued, would exercise an influence toward the upholding of high prices, there being small stocks of metal in the hands of large spelter manufacturers.

An order was issued early in the month by the State Railway Commission to the Chicago & Northwestern Ry. Co. to construct and maintain a branch from Strawbridge, on the Galena division, to the Skinner refinery, a portion of the expense to be furnished by the leading mining companies to be benefited. The new branch will afford relief to nearly all the zinc mines in the New Diggings district, all of which are at present compelled to team their ore to track. Mines isolated from hard-bottomed roads are frequently shut-off for weeks at a time at this season of the year. A sensational output of ore from the new Mulcahy mine, in the Shullsburg district, refined on the ground by an independent separating-plant, confirmed the claims frequently made by the lessees, the Oliver Mining Co., that it had in the making one of the best zinc ore mines in the field. The Rodhams Mining Co. introduced a new power and milling-plant during the month and began an increased output of both lead and zinc ore. In the Potosi camp, the Chicago Zinc Co. has a new 250-ton mill on property recently developed, but shipments will not begin until well along in January. Improvements in the plant of the Wilson Mining Co. enabled this concern to maintain regular shipments which will increase as the deposit is more fully developed.

VICTORIA, BRITISH COLUMBIA

Review of Metal Production During 1916.

A preliminary estimate of the total value of the mineral production of British Columbia in 1916 places the amount at about $45,000,000, compared with $29,447,508 in 1915, and $32,440,800 in 1912, the latter having previously been the year of highest annual value on record. While high prices for some of the metals are partly responsible for the marked advance, there were also substantial increases in quantities of lead, copper, and zinc.

Returns for gold, silver, and lead are incomplete, but those available indicate that there will be a decrease in the amount of gold produced. Water for washing gravel was short in the larger placer-districts, Atlin and Cariboo. The coke supply for smelting having been inadequate, the output of ore was somewhat curtailed at the bigger mines at Rossland and in the Boundary district, with a consequent smaller production of lode gold. The Hedley Gold Mining Co.'s output, while confirming previously announced average value of ore in reserve, was lower in quantity than in 1915. Another contributory to the decrease was a suspension of production at the Queen mine, Nelson division, while re-timbering the main shaft, timbers in which had collapsed.

There seems to have been more silver produced than in any other year since 1902, but lacking returns from several of the more productive mines of Slocan district, whence usually comes fully one-half of the silver produced, no definite statement can yet be made. An increase from East Kootenay, Ainsworth, and Coast district mines is expected, but a decrease in parts of West Kootenay appears likely.

Lead is thought to have made a substantial gain, probably between 40 and 50% in total quantity, chiefly from the Consolidated company's Sullivan mine. The Bluebell, Comfort, and Highland mines, in Ainsworth division, and the Galena Farm, Lucky Thought, and Ruth in Slocan division, shared considerably in the increase. The general utilization of lead-zinc ores now practicable makes for an appreciably large increase in the recoverable quantity of lead. Practically all the metallic lead included in the estimate of production was recovered at the Consolidated Co.'s smelting and electrolytic refining works at Trail, where additions to plant, etc., in the lead department, included a new lead mill, bedding system for roasters, another Wedge 7-hearth mechanical roaster, steel building over the Godfrey roasters, charge bins and weighing hoppers for the three large lead blast-furnaces, generator-room and more generators for the Cottrell dust and fume precipitation plant, and briquetting plant for flue-dust and lead fume.

Copper mining has become the most important branch of the mining industry of British Columbia. Provincial official statistics show a production in 1912 of 51,456,000 lb. of copper, and in 1915 of 56,918,000 lb. Returns for 1916 are not yet complete, but an estimate of 70,000,000 lb. is within the mark. Two districts, namely, those known respectiveley as Boundary and the Coast, are the present chief sources of copper ore. For 1915, the Provincial Mineralogist showed that of the above mentioned total, the Coast district, including the Granby company's mines near Observatory inlet and mines in the Hazelton region, produced 60.65%; Boundary district 30.57%; and Rossland mines 8.17%, leaving only 0.61% for other parts of the Province. For 1916 the proportions are estimated to have been approximately: Coast district, 69%; Boundary district, 23%; Rossland, 6%, and other parts 2%. In a report published recently, Alfred W. G. Wilson, chief of the Metal Mines Division, Canada Department of Mines, states that a rough estimate indicates that the known ore deposits of British Columbia contain in excess of 500,000 tons of recoverable copper, equal to 20 years' supply at the present rate of production, and suggests that other equally important discoveries will be made in the Province in the future. Incidentally, it is

noteworthy that a rough estimate of known copper ore reserves at the Granby company's mines in the Coast district is 18,000,000 to 20,000,000 tons; of those of the Britannia company, in the same district, 17,000,000 tons; and of mines in Boundary and Similkameen districts, 16,000,000 tons.

The question of refining copper in Canada had serious consideration in 1916. In his report, above alluded to, Mr. Wilson includes in his general conclusions the following: (1) British Columbia is the only province which produces enough copper annually to support an electrolytic refinery. (2) Within a short time the total amount of copper produced from districts tributary to the Pacific coast of British Columbia will probably be more than one-half the total production of Canada, and will be much in excess of that tributary to interior points. (3) For various reasons (cited in detail in the report) the coast of British Columbia offers the best choice of sites for a refinery.

Concerning copper smelting facilities: At Trail the Consolidated company has five copper blast-furnaces, with a smelting capacity of between 3000 and 4000 tons daily. Recent installations there include two copper converters and turbo blowing-engine for same; reverberatory-furnace and anode-casting plant. An electrolytic copper refinery, capacity 20 tons a day, has been built and equipped, and a copper refining furnace and casting equipment provided. In the Boundary district there are two copper smelters—those of the Granby and British Columbia copper companies. The Granby company has eight blast-furnaces, capacity 4000 tons per day, and three converter stands with 10 shells. Producing capacity is 50 tons of copper daily. The British Columbia Copper Co. has three blast-furnaces with a total capacity of 2000 tons, and two converter stands with seven shells. In the Coast district, the Granby company has at Anyox a blast-furnace capacity of 3000 tons, and three basic converters of the Great Falls type. Both Granby and B. C. companies ship their converter copper to eastern United States refineries. The latter company is developing a new copper field, near Princeton, Similkameen, with about 12,000,000 tons of ore estimated as available. It is intended to concentrate the ore by tables, jigs, and flotation, and smelt the concentrate. The Tyee Copper Co.'s works on Vancouver island have been inoperative for several years; last month their sale to New York men was reported, and it was stated $100,000 will be spent in modernizing the plant there. The Britannia company, near Vancouver, concentrates its copper ore and ships its concentrate to smelting works at Tacoma, State of Washington.

Production of zinc in British Columbia has been gradually increased in recent years, until now it is an important branch of the mining industry. In 1911 the quantity produced was 2,634,000 lb., in 1913, 6,759,000 lb., and in 1915, 12,982,000 lb. Production figures for 1916 are not yet available, but there is little doubt that it will be found the year's output was more than twice as much as that of 1915. The chief producer was the Consolidated Mining & Smelting Co., from its Sullivan mine, in East Kootenay, which shipped nearly 100,000 tons of lead and zinc ores to Trail during the year. At the end of 1915 the directors of the company announced that important additions to the works at Trail had been authorized to allow of the production of zinc on a commercial scale, and that a contract had recently been entered into with the Shell Committee for the supply by the company of a considerable quantity of zinc. The plant designed and then being erected was for a production of 25 to 35 tons of spelter per day, but later provision for more than twice that quantity was undertaken. The enlarged plant will allow of treatment of 600 tons of zinc ore daily, and production of 75 tons of electrolytic refined zinc. The equipment includes 13 Wedge mechanical 7-hearth roasters, Cottrell dust-precipitating plant, leaching-plant, electrolytic-tanks, melting-room, generator-room, laboratory, etc. The commercial production of electrolytic refined zinc or spelter was commenced during the year, and shipment of that product has been in progress for months.

Zinc concentrate in considerable quantity is made at half a dozen or more concentrating mills in the Slocan district, and the magnetic separation of iron from the zinc in concentrates is being successfully carried out at works at Kaslo, Kootenay lake. Besides the customary table and jig water concentration, flotation has been provided for in mills at Silverton, and Sandon, Slocan. A small part of the zinc concentrate produced in Slocan is shipped to Trail, but by far the larger part of it goes to reduction works in the United States. The utilization of the zinc in the ores adds considerably to the earnings of most of the larger companies operating in Ainsworth and Slocan divisions, as well as to the Consolidated company, with lead-zinc mines in East Kootenay.

The Standard Silver-Lead mine is to be prospected by diamond-drilling. The ore in this mine occurs as short lenses.

Vancouver Island coal mines made a gross production of approximately 1,510,000 long tons of coal, as compared with 1,020,000 tons in 1915. After deduction of coal made into coke, the increase was about 416,000 tons. The manufacture of coke, resumed by the Canadian Collieries (Dunsmuir) Limited, in 1915, to supply the Granby company for its smelter at Anyox, was enlarged in 1916, the output having been about 28,000 long tons, against 5450 in 1915. Coal mining was quiet throughout the spring and summer in Nicola district, but orders for coal could not all be filled, more miners being unobtainable, as winter came on. There was a decided increase in demand for coal from the Princeton colliery, Similkameen, especially from Vancouver, and difficulty was experienced in filling extra orders. Conditions in the Crowsnest district were unfavorable in several respects. Disasters at two of the Crow's Nest Pass Coal Co.'s mines, at Michel and Coal Creek, respectively; difficulty in obtaining sufficient miners and other workers, and suspension of work for short periods while demands for higher wages were being dealt with, all combined to restrict output of coal and lessen profits. Notwithstanding these drawbacks, however, the quantities of coal mined and coke produced were larger in 1916 than in 1915. The output of coal was about 812,000 long tons gross; deducting 353,000 tons made into 242,400 tons of coke, the net output of coal was approximately 459,000 tons. These figures compare with the 1915 production of 790,028 tons gross and 446,537 tons net of coal, and 240,421 tons of coke. The Corbin Coal & Coke Co. was the only other coal-mine operator in the Crowsnest district in 1916; its output was about 69,000 long tons against 62,544 tons in 1915.

Total production of coal in the Province in 1916 was nearly 2,496,000 long tons gross, and 2,070,000 tons net; of coke it was 270,475 tons. The corresponding figures for 1915 were coal, 1,972,580 tons gross and 1,611,129 tons net; coke, 245,871 tons.

Demands for higher wages made by workers in the metal mines and reduction works were adjusted amicably, generally, without suspension of operations. As in the coal mines, workers were short in some of the larger metal mines. The development of promising though not yet largely productive properties was continued, notably in Similkameen, Nicola, Lillooet, Vancouver Island, Alice Arm of Observatory Inlet, various parts of the Skeena and Babine regions, and Princess Royal island. Mine safety matters had more attention, safety committees having been organized at some of the larger mines and works, and appliances for the protection of the workers obtained. Much more attention was given to the mining possibilities of various fields in the Province by United States mining men, in several instances followed by activity.

The total amount paid in dividends by mining companies (more than $3,000,000) was larger, having about equaled the totals of the years of 1914 and 1915 combined. The dividend-paying companies were the Consolidated Mining & Smelting, Crow's Nest Pass Coal, Granby Consolidated, Hedley Gold, Rambler-Cariboo (Slocan), Sheep Creek Motherlode, and Standard Silver-Lead companies, several of which also made comparatively large additions to their profit and loss accounts or provision for discharge of debenture obligations.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

It has been officially stated by the United States Land Office that no leases of coal lands in the Matanuska and Bering River fields of Alaska have yet been made under the Act of October 20, 1914. The regulations under the Act were issued May 8, 1916, and eight applications have been filed for lands in the above coal-fields. Consideration is being given to these applications and it is expected that the awards will be made within a short time. The Land Commissioner states it is hardly probable that any mining will be done under the leases before the opening of spring.

JUNEAU. During December the Alaska Gold Mines produced 196,495 tons of $1.22 ore. The past year's returns were as follows:

	Tons	Value	Recovery, %	Residue, cents
December	196,495	$1.22	81.54	22.0
November	167,600	1.13	81.71	20.7
October	158,000	1.32	82.49	...
September	135,760	1.30	82.94	...
August	169,100	1.38	81.51	25.0
July	150,403	1.24	80.64	24.0
June	164,800	1.06	79.25	22.0
May	175,215	1.40	82.85	24.0
April	165,930	0.94	78.71	19.8
March	162,796	1.03	77.47	20.3
February	122,856	1.02	....	...
January	119,914	1.42	....	...
Total and average.	1,888,869	$1.23	81.00	22.0

The profit is estimated at $566,000, less $180,000 for 6% interest on $3,000,000 bonds. In 1915 the tonnage was 1,115,294, averaging $1.15 per ton.

ARIZONA

BISBEE. During December the Shattuck-Arizona mine yielded 1,419,339 lb. of copper, 285,404 lb. of lead, 16,352 oz. of silver, and 249 oz. of gold. The last three metals vary in quantity from month to month.

GLOBE. During 1916 the Iron Cap Copper Co. produced 1,629,897 lb. of copper and 60,027 oz. of silver from 10,360 tons of ore. After paying $35,329 on January 31 the surplus is $112,953. Ten feet of 10% bornite and covellite ore has been cut on the 800-ft. level, the most important development of the year.

The Old Dominion Extension Co. at Globe has taken options on several outlying groups of claims, although its original area includes more than 600 acres, much of it patented. Most of the directorate of the present concern will be succeeded by one of the leading copper operators of Arizona and his associates, insuring development of that promising prospect on a scale commensurate with its size and heavy surface mineralization. Although the present management has employed a fair number of men on the property (22 at present), its activity during the past two months has been more in the nature of preparatory work, consisting of road-building to shaft-sites from points where the Arizona Eastern railroad crosses the property, re-timbering and repairing of shafts already sunk on orebodies, etc. On the Iron Mask fault, ore has been developed continuously to a depth of over 100 ft. with steadily increasing value; at a depth of 115 ft. in the Sea Bird shaft a drift has opened the apex of a silver-copper orebody for a length of 200 ft.; at the Cuprite shaft a silver-bearing iron-manganese ore has been opened to a large extent during the past few weeks, a character of mineralization invariably capping the copper ores of the adjoining Old Dominion property. In the Cuprite workings the silver is already accompanied by copper.

(Special Correspondence.)—The Mineral Hill Mining Co. is preparing to erect a 400-ton concentrating plant at its property. The mine will furnish sufficient water for milling purposes.

The Schaaf mine, belonging to the Vulcan company, is shipping 500 tons of 7% ore per month. This property is owned by J. N. Pemberton and W. R. Ramsdell, and employs 80 men.

The Daily Arizona Consolidated Copper Co., under the management of J. W. Daily, has 15 men on its property north of Tucson. A new wagon-road is being surveyed from the mine to connect with the State highway, reducing the distance from 30 miles by the old road to 14 miles by the new one. The ore averages 6% copper, but several shipments averaged as high as 25%.

The Silver Dike property in the Dos Cabezos mountains is shipping $50 ore to the El Paso smelter. This property is owned by the White brothers of Dos Cabezos.

William J. Mitchell, general superintendent of the Standard Metals Co., states that the old Mowry mine in Santa Cruz county will be re-opened in January. He expects to employ 150 men. Years ago the Mowry was one of the best producers in Arizona.

W. R. Ramsdell has taken charge of the old Alamos mine, now known as the Pontoc. He is driving a cross-cut into the mountain and is extracting ore containing 7%. Thirty men are working, and a car of ore is being shipped daily. Until a month ago the mine had been idle for eight years.

James Neary, chief engineer for the Magma Extension near Superior, reports a rich strike of ore, running the entire width of the shaft. Assays show the ore to contain $20 per ton, in gold, silver, and copper.

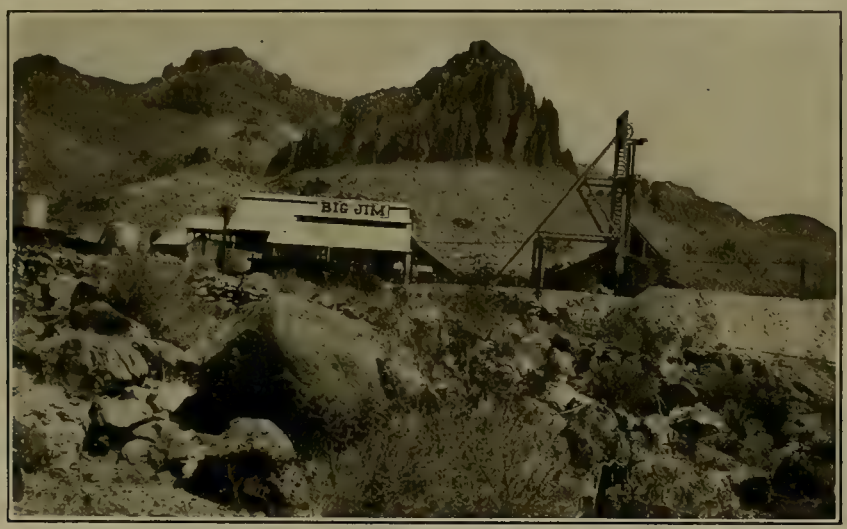
Tucson, January 3.

OATMAN. The Oatman *News* has the following to say about this district: "Despite all the alleged unfavorable conditions which should militate against gold mining and in favor of other metals, the Oatman district has more men at work and more properties active than at any time since last May. Actual development has been started upon fully a dozen properties within the past three weeks, and several more are preparing to join the active list. The new United Eastern 200-ton mill will commence to crush ore before the first of the year, giving Oatman one of the most modern plants and creating a new feeling of stability and confidence for the entire district. Preparations for the construction of the new plant to be added to the present mill of the Tom Reed company are being rushed, and it is hoped that the new unit will be in operation by May 1 of next year, as earlier deliveries of machinery and equipment are being secured than was anticipated. Plans for the Big Jim mill are being hurried to completion, so that the third new and modern plant for turning out bullion will be in active service much sooner than was expected. In addition to the operating properties, where over a 1000 men are now being employed in various capacities, there are hundreds of claim-owners now engaged in doing their annual assessment work, and this gives temporary employment at least to many others. Though Oatman is not enjoying or suffering from a boom,

the camp is bristling with good, honest, legitimate activity that presages better and sounder conditions than ever before."

The Big Jim mine at Oatman has been examined by H. V. Winchell, whose report is summarized as follows for the Oatman Bureau of Mines:

The tonnage and value of the ore already developed in little more than a year must be considered as exceedingly gratifying. There will certainly be more ore developed in all directions from the present openings. It has already been started, and good samples were taken on the 240-ft. level, although for lack of development no ore is estimated above a depth of 350 ft. The vein is strong in both east and west faces on the 400 and 485-ft. levels, and only needs further opening to increase rapidly the ore reserves. The work of driving should be pushed toward the north-west for two reasons: first, because the Big Jim holdings extend much farther in that direction, and second, because the ore-shoots rake in that direction



THE BIG JIM: ONE OF THE COMING MINES OF OATMAN, ARIZONA.

in the vein. There is no reason to question the existence of the vein in the Big Jim property for 1500 ft. farther to the north-west, and in that direction it is constantly approaching the Tom Reed and United Eastern mines, which as already stated are on branches of the same vein. A level at the depth of 600 ft. will in all probability double the value of the estimated ore, and is likely to encounter some of the Bonanza shoots for which the district is famous. The cost of mining and milling is also likely to be lower than the figure used in this report. Labor and supplies are now at a higher point than for many years, and will probably be lower by the time a mill should be constructed and in operation. Different engineers would probably arrive at different estimates of the tonnage and value of the ore already developed, and many estimates might he higher than that herein presented. Mr. Winchell says that his estimate is intended to be fair and safe, and represents his best judgment. The Big Jim is a real gold mine. It is in a proved district, it adjoins rich properties, and has a vein of unusual size. It has a good quantity of pay-ore already developed and a very promising future.

The United Eastern mill started work on January 4.

STODDARD. The Copper Queen Gold Mining Co. is making preparations to resume operations. Claude Ferguson has recently taken charge.

CALIFORNIA

On January 1, 1917, Boiler Safety Orders and Air-Pressure Tank Safety Orders became effective in California. These orders, issued by the Industrial Accident Commission, require that steam boilers operated in the State shall be subject to regular internal and external inspections each year. Air-pressure tanks are required to have an inspection not less than once every two years. Committees of employers and employees assisted the Commission in preparing the Orders. Section (c) of Boiler Safety Order 800 reads as follows: "Whoever owns or causes to be used a boiler subject to inspection shall report the location of such boilers to the Industrial Accident Commission of the State of California on January 1st, or within thirty (30) days thereafter, of each year." The Boiler Safety Orders provide rules and regulations for the fittings and appliances that must be used on existing installations, and also provide specifications to which new boilers must be built. These specifications are reproduced from the American Society of Mechanical Engineers' Uniform Boiler Code.

Air-Pressure Tank Safety Order 900 reads as follows: "Whoever owns, uses or causes to be used, any air-pressure tank which carries twenty-five (25) pounds or over pressure per square inch, shall report the location of the same to the Industrial Accident Commission within ninety (90) days after these Orders become effective." Safety Orders for air-pressure tanks contain provisions for the fixing of allowable pressures that may be carried and for certain fittings and appliances which are necessary on existing installations. With a few exceptions the specifications and regulations relating to the material and construction of new boilers in accordance with the Boiler Code are to govern the construction of all air-pressure tanks over twenty-four (24) inches in diameter.

The Industrial Accident Commission has also issued Safety Orders effective January 1, 1917, covering electrical utilization and trench construction. The Electrical Utilization Safety Orders cover safety standards for equipment, storage-batteries, transformers, lighting arresters, conductors, switches, fuses, switchboards, motors and motor-driven machinery, arc-welding, lighting fixtures and signs, portable devices, cables and connectors, etc.

The Trench Construction Safety Orders give standards for sheeting, shoring and bracing trenches, and define where they will be required. Copies of any or all of these Safety Orders may be obtained upon application to the Safety Department of the Commission, at 525 Market street, San Francisco, or Room 423 Union League building, Los Angeles.

AUBURN. Dredging on the north fork of the American river will soon begin. The Guggenheims have leased on a percent-

age basis the claims of several owners along the river for 12 miles. A large portion of the property to be dredged belongs to the Central Pacific Railroad Co. and the Pacific Portland Cement Co.

BAGBY. There is more activity in this district of Mariposa county than usual. The U. S. S. R. & E. Co. has taken the Mary Harrison claims under bond and lease, and has three shifts clearing out old workings, also sampling.——At the Virginia, concentrators were installed in the 10-stamp mill. Within 30 days two carloads of concentrate was sent to the Selby smelter, netting $51.15 per ton.——At the Red Bank the new flotation plant is being tried. Wilfley tables have been installed.——It is reported that the Mariposa Grant people will extend the 3500-ft. adit at Bagby another 1200 ft., and then cross-cut. Prospectors and lessees are busy on the estate, but no company work has been done for some years.

(Special Correspondence.)—The Headlight electric power-plant, which has been supplying power to the dredges at Trinity Center for several years, and which was owned by Atkins, Kroll & Co. of San Francisco, has been sold to the Oregon-California Power Co. The plant will continue to deliver power, but will be connected in parallel with the Oregon-California power line, which will carry the peak load. The Oregon-California line was brought into Trinity county from Yreka by way of Castella last year for the purpose of supplying power to the Pacific Gold Dredging Co.'s boat lately completed, to No. 2 dredge to be constructed this year, and to the boat to be constructed by W. H. Estabrook at Trinity Center, the present terminus.

Carrville, January 4.

COPPEROPOLIS. The Calaveras property is being arranged to increase the output. The main shaft is to be connected with the Union shaft.

DAMASCUS. The Pioneer mine near here in Placer county is to have a larger mill. The capacity of the old plant is 75 tons per day; with the additional machinery it will be raised to 300 tons. The new mill will be equipped for fine-grinding and cyanidation.

GEORGETOWN. The Darling Consolidated mine in Eldorado county, 8 miles east of this town, is to be equipped with a new modern plant, including a hoist, compressor, mill, and other machinery. W. R. Usher, 42 Broadway, New York, is interested.

HAPPY CAMP. The Gray Eagle Copper Co., a subsidiary of the Mason Valley Mines Co. of Nevada, is reported to have bought the Ely group of claims near here, and work will be started as soon as the weather permits. The Gray Eagle company has completed a three-mile road, and is taking in equipment over it.

HORNITOS. The Ruth Pierce mine five miles east of here, in Mariposa county, has been in operation for three months after a long idleness. It was at one time a substantial producer, and indications are favorable for it again becoming important, as each succeeding monthly clean-up is larger than that before. George McMahon is manager.

LAST CHANCE. The Glen Consolidated drift mine near here, in Placer county, is working although completely buried beneath the deep snow. All buildings and the entrance to the mine are connected by covered passages, and the snow has blanketed mine, buildings, and the entire country to a depth of several feet. There are 50 men employed. The mine is operated all year round, notwithstanding the snow.

OROVILLE. M. F. Reed and J. T. Tallivand have a lease on the Wagstaff mine in Butte county, and are preparing to unwater the old workings.

MOKELUMNE HILL. The Esperanza mine, 2½ miles north-east, has been sold and is to be re-opened. The workings are 1000 ft. deep.

MOUNTAIN RANCH. It is reported that rich gold ore has been found in the Shenandoah mine, on Jesus Maria creek, near here, in Calaveras county. This old mine was re-opened last year after a long idleness and is now being operated by the Amapalo Gold Mining Co. The strike was made near a raise cut to get into the region of old stopes that formerly produced a good grade of ore. The mine is equipped with a 10-stamp mill, and will probably add a cyanide plant the coming spring.

(Special Correspondence.)—An encouraging development was made at the Central Eureka mine this week, the shaft, during sinking, having cut ore that assays over $30 per ton. The entire bottom of the shaft is now in ore. This shoot comes in from the hanging wall, and its discovery at this time is not only gratifying but unexpected, as the intention was to have stopped sinking at about the present depth, and to have started a cross-cut to strike the ore on a level 150 ft. below 3200 ft. Before the resumption of sinking on November 20, the shaft was down 60 ft. below the 3200-ft. station. Progress of 15 ft. per week has been made in sinking since the company let the work on contract, so that the shaft has reached the proposed depth of 3350 ft., including the 90 ft. of new shaft. As the property is being operated at the present time partly on assessments, finding the ore in the shaft without the necessity of running a long cross-cut, means much to the company. The new ore is being crushed with most satisfactory results, and two additional batteries have been started, 30 stamps of the 40-stamp mill now being in operation. When sinking commenced, it was expected that only half of the mill could be kept in operation until the shaft was down and a new level opened below 3200 ft. Fred Jost is superintendent and W. J. Bryant foreman of this property, which lies between the South Eureka and Old Eureka mines.

The Old Eureka shaft has been re-timbered to the 1400-ft. level, and the pumps have been throwing water with such good effect that the shaft is clear for about 200 ft. below that point. A little prospecting is being done on the 800-ft. level, where there is already opened some ore that assays well. The delay in arrival of electric motors, ordered nearly a year ago, impedes progress of surface construction, and little has been done on the new head-fame during the past two weeks, but the electric machinery is expected early next month, and the other work will then be pushed more vigorously.

Sutter Creek, January 12.

COLORADO

CRIPPLE CREEK. During January dividends will be paid by the Doctor-Jack Pot, $28,441; Cresson, $122,000; Golden Cycle, $45,000; Vindicator, $45,000; and Portland, $90,000.

GEORGETOWN. Ore from the Imperial mine is being sampled and tested by Mr. Le Brun to determine the best method of treatment. Whatever is decided upon, will be installed in the old Waldorf mill.

IDAHO

Three Coeur d'Alene companies have declared initial dividends for 1917, namely, the Bunker Hill & Sullivan, $163,500 on January 4, Caledonia, $78,150 on the 5th, and Hecla, $150,000 on the 20th. The total of 9 companies in 1916 was $10,925,698. The Hercules led with $3,000,000, followed by Interstate-Callahan with $2,789,940, Bunker Hill & Sullivan with $1,726,750, and Hecla with $1,555,000.

According to the State mine inspector, Robert N. Bell, the output of the region in 1916 was

Metal and unit	Quantity	Value
Lead, pounds	338,760,000	$23,001,804
Zinc, pounds	105,221,000	12,668,207
Copper, pounds	1,238,000	331,412
Silver, ounces	11,201,000	7,251,527
Gold, ounces	2,500	50,000
Total value		$43,302,950

The value is $10,000,000 more than in 1915.

Wages paid by Coeur d'Alene companies in 1916 totaled

$7,800,000. Owing to the sliding-scale for lead, the men received $1,560,000 additional, this being included in the above total.

OROGRANDE. The Hogan mine has a large body of low-grade ore being developed and it is expected to begin production by May 1. It is said that the gold-bearing dike runs through the country for two miles. It is the intention to spend $300,000 in the equipment and development of the property. The mine was worked years ago and has a record of production reaching $125,000. However, the cost of operations at that time permitted no profit to be made. With modern appliances and methods a substantial profit is expected.

MICHIGAN

HOUGHTON. Wages paid by copper companies in 1916 totaled $18,900,000. Of this the Calumet & Hecla distributed $5,502,000, and its subsidiaries $5,000,000.

MISSOURI

The November bulletin of the School of Mines and Metallurgy at Rolla contains a study on the origin of Missouri cherts and zinc ores. The publication is illustrated with plates showing the rocks.

NEVADA

BELMONT. The Monitor-Belmont mine is being developed steadily, and it is expected that the 100-ton oil-flotation plant will be operated to full capacity during 1917.

The Old Barcelonia mine, 7 miles west of Belmont, is again being opened and new machinery installed. Mr. Pike of the Jim Butler at Tonopah is in charge of development and the installation of machinery.

The Belmont Big Four, with mines on Antone creek, 8 miles west of Belmont, has purchased a stamp-mill in Colorado and will ship it to Belmont and add a flotation plant of 100-ton capacity. The company is selling 100,000 shares at 2½c. each cash, and 200,000 shares at 5c. per share on 10 monthly payments, proceeds to be used in completing mill and flotation plant. The mine has a large vein of molybdenite. Concentrate is worth from $3000 to $4000 per ton.

The old Tybo mine, 20 miles east of Belmont, has been leased by the Louisanna company of New York, with a view to treating the dump and opening old workings.

The old Monarch property has been sold to people from Ellsworth, who will move a mill from there to the Monarch.

In a general way it may be said that Belmont is reviving and will be a good district in 1917.

GOLDFIELD. According to George Wingfield, the Goldfield Consolidated is to throw open certain blocks of its mine to lessees. The policy which in the future will be followed by the company in granting leases will be the split-check system, in which the company supplies machine-drills, sharp steel, tools, timber, track, rails, and all supplies except powder to the lessees free of charge, and in addition hoists the ore after it has been delivered to the company. A deduction of $4 per ton will be made from all grades of ore to cover the expense of transportation, sampling, and milling. Ninety per cent of the gold-value, based on gold at $20 per ounce, will be figured as the net recovered value of the ore. From this recovered value the deduction of $4 per ton will be made, and the remaining profit will be divided with the lessee. This form of lease will apply to the portion of the company's estate from which ore will be hoisted through the working shafts of the company. On outlying portions of the company's estate and all portions not connected with any of the main workings of the company, a similar but slightly modified form will apply. The lease maps are being prepared and blocks outlined as rapidly as possible, but it will be a matter of a few weeks before all of the details have been arranged.

MINA. The Table Mountain copper district, 12 miles east, is attracting some attention. Reno people have recently secured a lease on the Clay Peters mine, from which lessees have been extracting ore.

RAND. In this district of Mineral county, 45 miles east of Luning, the Copper Mountain property has been optioned to the Jumbo Extension company of Goldfield. Lessees have already extracted rich copper ore from the mine.

TONOPAH. In the *Miner* of January 6, Jay A. Carpenter tabulates and discusses the cost of mining and milling at Tonopah in 1915. The daily tonnage at the mills varies from 117 to 453 tons each, the grade of ore from $13.66 to $19.25, mining cost $4.11 to $5.42 per ton, and milling $2.95 to $5.02 per ton. The gross recovery is from 81.7 to 92.97%.

The report of Frederick Bradshaw, general superintendent of the Jim Butler Tonopah Mining Co., for the year ended September 30, 1916, contains the following:

Development amounted to 10,428 ft., costing $7.58 per foot. Ore reserves are estimated at 19,158 tons. The property was considered to have great possibilities under further exploration, and work done brought out valuable geological information for future development. There was sold 46,489 tons of ore, averaging 0.274 oz. gold and 24.82 oz. silver per ton, equal to $19.78 per ton. The net realization was $359,387, against $345,463 in 1915-'16. Total operating costs were $10.80 per ton, an increase of 40c. This included 83c. for transportation of ore to the Millers plant. Dividends (2) amounted to $343,604. Cash on September 30 was $267,724.

To the end of 1916 the Tonopah mines have produced silver and gold worth $100,346,899. Of this, $28,689,240 has been distributed to shareholders.

The Belmont company's profit in 1916 was $1,151,482; that of the Extension was about $765,000.

The Diamondfield Black Butte Co. is about to begin the development of the Orizaba silver mine, 40 miles north-west of Tonopah. The greater part of the necessary machinery is at the mine and it will soon be in operation. Heretofore the best ore has been shipped by auto-trucks to the railroad, and then to the smelter.

NEW MEXICO

It is estimated that the total production of all industries in this State last year was $200,000,000. Of this, mining contributed $45,000,000, or over 20%.

(Special Correspondence.)—For the last half of December the Mogollon Mines Co. produced 14 bars of gold-silver bullion and 3½ tons of high-grade concentrate. The company has installed a crude-oil burner under a boiler for heating solutions during cold weather. Tests have demonstrated that oil at 15c. in Mogollon is cheaper than wood at $9, and since the actual price of the latter is $12 per chord, the saving is appreciable.

Another pack-train has been added at the Pacific mine to move an old ore-dump from the portal of the adit to the terminal of the wire-rope tram to the Socorro company's mill, at which latter point the product is being treated. The tramway is giving entire satisfaction.

The Queen lode is receiving further attention by work just started north of Cooney on the Admiral Dewey-Apache group, comprising over a mile of the vein, owned by Spokane and Canadian capitalists.

Mogollon, January 2.

SOUTH DAKOTA

DEADWOOD. J. T. Milliken, who is already interested in this district at the Oro Hondo, is to resume work at the Montezuma and Whizzers property in Deadwood gulch, near the town. Large quantities of pyritic ore is known to exist.

UTAH

Owing to the cold weather and large snow fall there is reported to be more difficulty this winter in unloading ore from cars than ever before. Smelters receive carloads of ore frozen solid. Concentrates from Idaho also arrive frozen.

The Mineral Mountain range in Millard and Beaver counties is reported to be busy. There are 20 properties being developed, some of which are shipping ore, while others have good prospects.

ALTA. The snow has been cleared from this district, and after a week's suspension ore is again being sent to smelters. The mines are generally in good condition, but the winter is hindering work.

BINGHAM. The Utah Apex Mining Co. reports that for the 6 months ended November 30, 1916, the net profit from $636,059 gross receipts was $144,366. In June the profit was $43,665, in November $10,536. The ore available for milling was reduced to a small quantity, but development was increased threefold, and prospects are brighter. A smelting contract made early in the year entailed heavy charges. Zinc-iron middling is to be sold on favorable terms to the Zinc Concentrating Co.

TINTIC. Salt is used (150 tons per week in treating 1400 tons) during the roasting of ores at the Tintic Milling plant, but owing to storms delaying deliveries the works were closed for several days last week.

On January 25 the Iron Blossom company pays 10 cents per share. The treasury contains $220,000. The output of 200 tons daily is sent to the Tintic Milling plant.

On January 25 the Dragon Con. pays 1 cent per share, equal to $18,750.

The new hoisting outfit at the Tintic Standard mine is in successful operation. The shaft is to be sunk from 300 ft. to a depth of 1000 ft. This new shaft is 1700 ft. from the original shaft, and from which a large orebody is being developed on the 1300-ft. level. It is believed that this orebody extends to the new shaft and will be cut by it in sinking.

WYOMING

CHEYENNE. Bulletin No. 13 of the Geologist's Office is by Victor Ziegler, and discusses the Pilot Butte oil-field in Fremont county. The oil is of high-grade paraffin base. Possibilities of future development are considered good. A deep test well is to be drilled, and a pipe-line is to be put down to the railroad, 33 miles.

CANADA

BRITISH COLUMBIA

GOLDEN. Ten feet of 24 to 33% copper ore has been uncovered by J. W. Conner in his Tennessee claim in the north-east Kootenay district. Shipments are being made.

PRINCETON. It is reported at New York that the Canada Copper Corporation, which has a smelter at Greenwood, may construct a 13-mile railroad and 2000-ton mill near Princeton. The ore will come from the huge Copper Mountain property.

SILVERTON. Rich lead-silver ore has been opened in the lower level of the Echo mine, and exploration has followed the shoot 85 ft. to a depth of 600 ft. Some of the ore contains zinc and gray copper. The company is considering the erection of a mill. J. H. Thompson is manager. Seattle people are interested.

TRAIL. The reduction works of the Consolidated Mining & Smelting Co. of Canada have been described recently in detail in this journal, and the report of the company for the year ended September 30, 1916, contains the following information:

At the mines (17) there were no extraordinary occurrences, the usual policy of keeping development (18,519 ft. and 20,975 ft. of drilling) well advanced being maintained. The smelter treated 447,017 tons of ore, yielding 98,314 oz. of gold, 2,285,631 oz. silver, 39,974,411 lb. of lead, 4,446,080 lb. of copper, and 3,088,199 lb. of zinc, mostly electrolytic metal. Sales of products realized $7,203,807. The profit was $996,496. Dividends absorbed $776,338. Ores, metals, etc., on hand total $2,682,934. Cash amounts to $190,742.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

N. H. RUBY is at Nogales.

F. L. SIZER is now at Reno.

T. J. JONES has returned to London from Siberia.

J. F. MITCHELL-ROBERTS has arrived here from Korea.

H. C. HOOVER is due to arrive today at New York, from London.

IVAN RAGAZ, operating in Coahuila, Mexico, is in San Francisco.

W. F. STEVENS, of Lovelock, Nevada, visited San Francisco last week.

C. M. WELD has removed his office to No. 2 Rector street, New York City.

W. D. THORNTON is visiting the Inspiration and other copper mines in Arizona.

ROBERT HAWXHURST, JR., is now manager for the Eden Mining Co. in Nicaragua.

EARL B. CRANE, of the Black Butte quicksilver mine, Oregon, was here during the week.

DAVID T. DAY passed through San Francisco from Los Angeles on his way to Wyoming; then to Washington.

R. C. GEMMELL, manager of the Utah Copper Co., has been in San Francisco, in consultation with D. C. JACKLING.

ELLARD W. CARSON is now superintendent of the Oceanic quicksilver mine, San Luis Obispo county, California.

W. H. SHOCKLEY has been elected chairman of the San Francisco section of the American Institute of Mining Engineers.

E. T. MCCARTHY has returned to London from a visit of inspection to the Spassky and Atbasar copper mines in Siberia.

E. W. MILLS and J. F. MANNING attended the recent meeting of the local section of the A. I. M. E. They are going to China shortly.

ROY F. HEATH has resigned as chemist for the U. S. Mining Co. and has opened an assay-office at White Sulphur Springs, Montana.

FREDERICK G. CLAPP, of New York, addressed the Geological Society of America at Albany, N. Y., on December 28, on the 'Ethics of the Petroleum Geologist.'

M. H. SULLIVAN has resigned from the staff of the Consolidated Mining & Smelting Co., at Trail, B. C., to become superintendent of the New Bunker Hill smelter, at Kellogg, Idaho.

H. F. DEXTER, secretary and treasurer of the company publishing this paper, fell from the second story of his home at Alameda, while under the effect of an attack of vertigo, on the morning of January 14. He broke a leg and an arm and lies in a serious condition. The accident has aroused keen sympathy in this office and outside.

JOHN D. POPE, who was in charge of the mining operations of the North Butte Mining company at Butte from its organization until 1916 and was general manager for the last six years of his connection with that company, has been appointed general manager of operations in Montana for the Boston & Montana Development Company.

The UNIVERSITY OF CALIFORNIA announces that on January 18, 19, 21, 23, 25, and 26, at 8 p.m., Robert A. Millikan, professor of physics in the University of Chicago, will lecture on electricity, X-rays, the electron, Brownian movements, the atom, and radiation.

The new buildings for the TEXAS SCHOOL OF MINES, at El Paso, to cost $100,000, are being designed. They will be erected at the foot of the Franklin range. The style of architecture is Bhutanese, and the material will be of stone and concrete.

THE METAL MARKET

METAL PRICES

San Francisco, January 16.

Antimony, cents per pound	12
Electrolytic copper, cents per pound	35
Pig lead, cents per pound	7.75— 8.75
Platinum, soft and hard metal, per ounce	$85—91
Quicksilver, per flask of 75 lb	$80
Spelter, cents per pound	13
Tin, cents per pound	42.50
Zinc-dust, cents per pound	18

ORE PRICES

San Francisco, January 16.

Antimony, 50% metal, per unit	$1.00
Chrome, 40% and over, f.o.b. cars California, per ton.	15.00
Magnesite, crude, per ton	6.50— 9.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO_3, per unit	18.00—20.00

New York, January 9.

Tungsten: Sales have been made in the week at $17 to $17.50 per unit. In stating that the Western price basis is lower than that at New York, a broker explains that the firmness in the East is due to the fact that sellers have a wider market, selling for export as well as to domestic consumers.

Molybdenite: The market is quiet and unchanged at $1.75 to $1.85 per lb. MoS_2 contained.

Antimony remains exceedingly dull with hardly any business to speak of. The quotation for forward antimony is 11¾ to 12c. in bond, with spot duty paid antimony quoted 14 to 14½c. Needle antimony is offered at 10 to 11 cents.

EASTERN METAL MARKET

(By wire from New York.)

January 16.—Copper is quiet with little offering. Demand for lead is awakening and is stronger, at 7.50 throughout the week. There are few sellers of spelter and buyers are bidding higher. Platinum is offered at $90 for soft and $96 for hard.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Jan. 10	75.00	Dec. 5	75.05
" 11	75.00	" 12	75.37
" 12	75.00	" 19	76.35
" 13	74.37	" 26	76.05
" 14 Sunday		Jan. 2	75.37
" 15	74.37	" 9	75.28
" 16	74.25	" 16	74.66

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90	47.52	63.06
Feb.	57.53	48.45	56.74	Aug.	54.35	47.11	66.07
Mch.	58.01	50.61	57.89	Sept.	53.75	48.77	68.51
Apr.	58.52	50.25	64.37	Oct.	51.12	49.40	67.86
May	58.21	49.87	74.27	Nov.	49.12	51.88	71.60
June	56.43	49.03	65.04	Dec.	49.27	55.34	75.70

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Jan. 10	27.75	Dec. 5	34.10
" 11	28.00	" 12	34.87
" 12	28.00	" 19	34.04
" 13	28.50	" 26	31.55
" 14 Sunday		Jan. 2	29.90
" 15	28.75	" 9	28.20
" 16	29.00	" 16	28.33

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	14.21	13.60	24.30	July	13.26	19.09	25.66
Feb.	14.46	14.38	26.62	Aug.	12.34	17.27	27.03
Mch.	14.11	14.80	26.65	Sept.	12.02	17.69	28.28
Apr.	14.19	16.64	28.02	Oct.	11.10	17.90	28.50
May	13.97	18.71	29.02	Nov.	11.75	18.88	31.95
June	13.60	19.75	27.47	Dec.	12.75	20.67	32.89

December production of Cerro de Pasco totaled 5,500,000 lb. of copper, against 5,700,000 in November, 6,000,000 in October, and 5,800,000 in September.

Mohawk Mining Co.'s banner year resulted in earnings better than $2,000,000 in 1916, equal to over $20 per share. A new monthly record was also made in December with production of more than 1000 tons of mineral. The February semi-annual dividend is announced at $10 per share.

November output of Ray Consolidated Copper was 7,164,736, against 7,590,038 lb. in October. Ray contributed 15,000,000 lb. to the increase in 1916 over that for 1915. At the outset of 1916 the company turned out copper at the rate of 50,000,000 lb. per annum, while it closed the year on the basis of 85,000,000 lb. per year.

Work is suspended on new leaching plant of Utah Copper Co. owing to cold weather. General Manager R. C. Gemmell says the plant will be completed by the time machinery is delivered from the East. Utah copper is handling 20,000 tons of ore daily. While this is the normal capacity of the plants, the production reached as high as 40,000 tons per day last year and averaged slightly more than 31,000 tons daily. The December production of less than 15,000,000 lb. was the smallest during 1916.

In December Anaconda produced 29,000,000 lb. of copper; the total for 1916 was 336,900,000 lb. Shattuck-Arizona, 1,419,333 lb. Production of the Braden company was 4,716,000 and Kennecott 6,800,000. In December, Chile Copper turned out 6,118,000 lb. and Greene-Cananea 4,975,000 pounds.

Labor troubles are curtailing refinery production in New Jersey.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Jan. 10	7.50	Dec. 5	7.32
" 11	7.50	" 12	7.73
" 12	7.50	" 19	7.69
" 13	7.50	" 26	7.50
" 14 Sunday		Jan. 2	7.49
" 15	7.50	" 9	7.50
" 16	7.50	" 16	7.50

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80	5.59	6.40
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67	6.28
Mch.	3.94	4.04	7.26	Sept.	3.82	4.62	6.86
Apr.	3.86	4.21	7.70	Oct.	3.60	4.62	7.02
May	3.90	4.24	7.38	Nov.	3.68	5.15	7.07
June	3.90	5.75	6.88	Dec.	3.80	5.34	7.55

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Jan. 10	9.50	Dec. 5	13.20
" 11	9.25	" 12	12.25
" 12	9.25	" 19	11.13
" 13	9.25	" 26	10.00
" 14 Sunday		Jan. 2	9.75
" 15	9.50	" 9	9.66
" 16	9.75	" 16	9.37

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75	20.54	9.90
Feb.	5.22	9.05	19.99	Aug.	4.75	14.17	9.03
Mch.	5.12	8.40	18.40	Sept.	5.16	14.14	9.18
Apr.	4.98	9.78	18.62	Oct.	4.75	14.05	9.92
May	4.91	17.03	16.01	Nov.	5.01	17.20	11.81
June	4.84	22.20	12.85	Dec.	5.40	16.75	11.26

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date.			
Dec. 19	80.00	Jan. 2	80.00
" 26	80.00	" 9	80.00
		" 16	80.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	39.25	51.90	222.00	July	37.50	95.00	81.20
Feb.	39.00	60.00	295.00	Aug.	80.00	93.75	74.50
Mch.	39.00	78.00	219.00	Sept.	76.25	91.00	75.00
Apr.	38.90	77.50	141.60	Oct.	53.00	92.90	78.26
May	39.00	75.00	90.00	Nov.	55.00	101.50	79.50
June	38.60	90.00	74.70	Dec.	53.10	123.00	80.00

TIN

Prices in New York, in cents per pound.

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60	37.38	38.37
Feb.	39.76	37.23	42.60	Aug.	50.20	34.37	38.88
Mch.	38.10	48.76	50.50	Sept.	33.10	33.12	36.66
Apr.	36.10	48.25	51.49	Oct.	30.40	33.00	41.10
May	33.29	39.28	49.10	Nov.	33.51	39.50	44.12
June	30.72	40.26	42.07	Dec.	33.60	38.71	42.55

PLATINUM

Price of platinum, New York, is $90 per ounce for soft metal and $96 for hard.

Eastern Metal Market

New York, January 10.

A sharp decline in the quotations for re-sale copper appears to have come to a halt, leaving prices nominal for the reason that they are no longer attractive to sellers.

Zinc is lower under pressure to sell, some of which is attributed to German interests who believe that the War will be ended soon.

Lead has been dull, but firm.

The tin market has been quiet except on two days when buying was active.

Antimony continues dull.

The figures of the United States Geological Survey indicating increased production of all the metals had no serious effect on the market, although it is everywhere recognized that the larger production must be reckoned with after the War, and possibly before its end. While unconfirmed, the rumor persists that both copper and zinc are being offered by representatives of the Central Powers who are convinced that the end of hostilities is near. Another conjecture concerns the possibility of Great Britain having some of the metal she purchased, delivered against her munitions contracts in this country, instead of its being exported in unwrought form. All of this guesswork indicates the extent of the uncertainty which prevails.

The specifications which the steel mills are receiving show no diminution, but consumers are more reluctant about placing orders for second-half delivery, nearer than which there is nothing available, except odd lots at premium prices. This situation does not pertain to plates or rails. Shipyards the world over are seeking plates in the United States, and some have placed orders into 1918. Shell orders apparently are a thing of the past, the Allies having failed to take advantage of options they had with American firms. Canada, as intimated a week ago, is steadily putting herself in better shape to handle the munitions requirements of Britain.

Foundry pig iron is dull but strong. Steel-making iron continues in heavy export demand. The metal-working machinery trade continues under great pressure.

COPPER

Offerings of re-sale copper have been made in the past week at steadily declining quotations with the result that the market has reached a level where prices are no longer attractive to sellers. Extreme dullness and nominal prices is the condition today. Prompt electrolytic was quoted yesterday around 27.75c. to 28c., with persistent rumors that it could be had for less. First quarter was quoted at 27c. to 27.50c., and second quarter at about 26c. Lake was at the same level. The situation is an uncertain one, and theory is taking the place of facts in efforts to explain conditions. One story that is heard, but which has not been confirmed, is that representatives of the Central Powers, confident of the early termination of the War, are selling metal for which they are known to have paid 18c. to 20c. several months ago. On the other hand, it is known that consumers who were induced to gorge themselves with copper, largely through fear, are now anxious to sell their surplus. It is believed, however, that prices have reached a point where these consumers would suffer a loss if they sell, and that this accounts for fewer offerings in the past day or two. The producers are doing no business. There is no question of their being well sold up over the first half. They are not quoting for the last half, at least at prices that will win business. For them to make prices comparable to those which the second hands have been making for the first half would be a confession of the weakness of the market, and might induce cancellations of contracts. It is not improbable that there will be cancellations, or, at least, requests for postponment of deliveries, and, needless to say, their position is not altogether a comfortable one. A possibility that some of the trade is considering, is the likelihood of Great Britain having some of the metal it has under contract delivered against its munitions contracts now being executed by American firms. All of this is conjecture. The London quotation for spot electrolytic yesterday was £143 against £145 a week previous. The exports, January 1 to 10 totaled 6162 tons.

ZINC

The market has been hard-hit this week, and allegations are frequent that a deliberate effort was made to depress the market. However that may be, the fact is that quotations are lower, and that zinc is easily obtainable at the lower prices. On Monday of this week a broker on the floor of the New York Metal Exchange offered January delivery at 9.25c., St. Louis; February at 9c., and March at 8.75c., 60 tons of each. No one was interested, and later the offering was criticized as not being *bona fide*. The critics were invited to attend the Exchange the following day, and again the metal was offered at the same prices, with the result that it was taken. More zinc was offered at the prices named than was wanted. The New York quotations are ¼c. higher. In zinc, as with copper, it is suspected that certain German interests are trying to unload at prices that will net them a profit. While the figures of the Geological Survey, indicating increased production in 1916, have done little harm to the market, they did little to help it. It is hoped that Great Britain will soon buy zinc, inasmuch as she has never bought in quantity proportionate to her purchases of copper. The exports January 1 to 10 total only 1013 tons. The London spot quotation yesterday was unchanged at £50 5s. Sheet zinc is unchanged at 21c. per lb., carload lots, f.o.b. mill, 8% off for cash. It is being much used as a substitute for sheet brass.

LEAD

This metal has been dull, and entirely without feature in the past week. Quotations have been firm at 7.50c., New York, and 7.37½c., St. Louis. The Western market has eased off just a trifle as compared with a week ago. With regard to the statistics, the only comment of the trade is that the increased production is something that must be reckoned with after the War, and possibly sooner. This, of course, applies to all the metals the production of which has been increased. The London quotation yesterday was £30 10s., unchanged from a week ago. The exports, January 1 to 10 totaled only 305 tons.

TIN

On January 4 the market was active, about 300 tons changing hands, and again yesterday (January 9) another 300 tons was taken. Otherwise the market has been dull all the week, but prices have remained fairly firm. The quotation for spot Straits yesterday was 42.50c., and for spot Banca 42c. The feature of the buying on the two days referred to was that the transactions were confined to a few buyers and sellers. It was almost entirely on local account, the tin-plate mills having covered their requirements some months ago. As recently predicted, the brokers and sellers of tin are encountering difficulty in getting specific information concerning shipments from the other side. Agents of the steamship lines sometimes flatly refuse to give information as to sailings or times of arrival, their attitude, of course, being designed to protect their vessels against submarine activities. The arrivals this month total 1520 tons, and there is afloat 4333 tons. New projects for the smelting and refining of Bolivian ore are in motion, more of which will be said next week, after details can be secured.

Mining and Scientific Press

Edited by T. A. RICKARD

Volume 114
Number 4

SAN FRANCISCO, JANUARY 27, 1917

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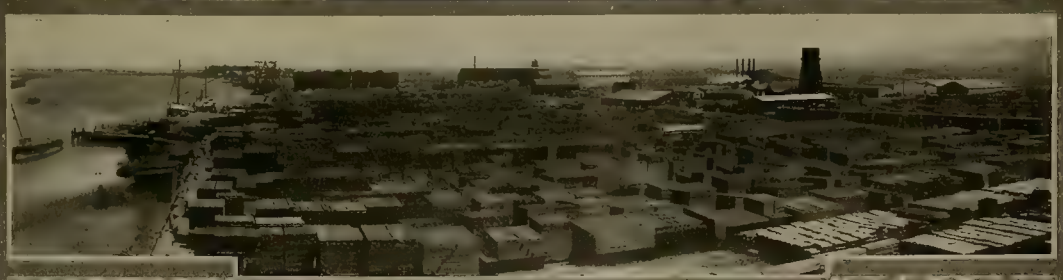

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An Interview With John H. Mackenzie, a Superintendent of Mines

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UNION CONSTRUCTION COMPANY

The Union Construction Page

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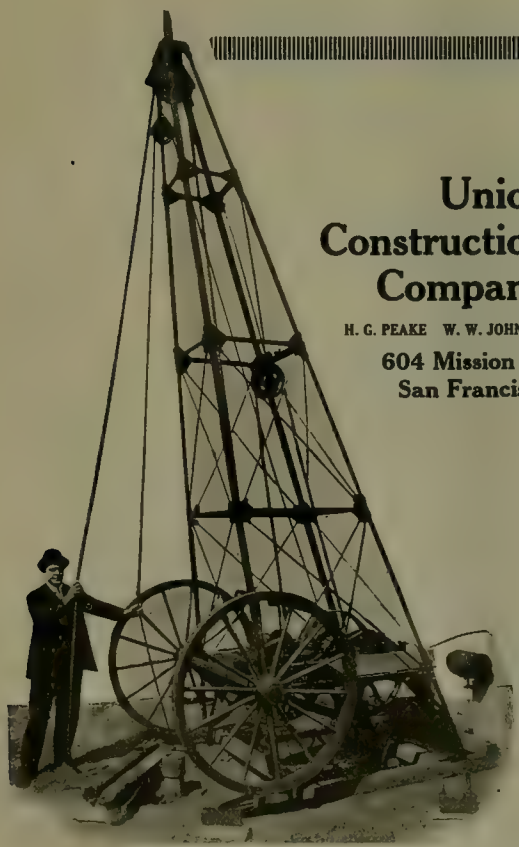

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EDITORIAL

T. A. RICKARD, Editor

THE index to Volume 113 of the MINING AND SCIENTIFIC PRESS is now ready for those that ask for it.

THOSE that are interested in Mexican affairs should not fail to read the long article from our own correspondent appearing in our last issue. We omitted to draw attention to it last week, but it was a most timely and informing contribution.

BUSINESS proceeds with persistent momentum, but recent events have given a salutary check to exhuberant buoyancy. Between fear of peace and dread of prolonged warfare we are learning to take short views of life. The rising cost of living has compelled even the most thoughtless to pause and ponder over the state of the world.

ANNOUNCEMENT is made that the American Smelting & Refining Co. is to undertake the manufacture of chemicals on a large scale. The sulphuric-acid plants attached to the company's smelters in the Salt Lake valley are to be greatly enlarged and other kinds of chemicals are to be produced at other plants to be erected elsewhere by the company.

SOME natural curiosity has been expressed as to the source of the $979,000,000 of gold that has been imported into the United States since the War began. There should be no mystery. The gold mines in the British and Russian dominions together produce $325,000,000 worth of gold per annum. In 2½ years the aggregate contribution would be $812,500,000.

INTELLIGENT anticipation is an essential part of Stock Exchange activity. That is why the doings of the share market are held to foreshadow coming events. Those that gamble on the effect of such events are bound to take pains to ascertain what is happening or is likely to happen. The Lawson bid for notoriety is not needed to assure us that information does 'leak' to Wall Street. Statesmen consult with bankers, and even Presidents must discuss matters with other people. Only an autocrat can plan great measures in absolute secrecy.

DAVID H. BROWNE never fails to illuminate any subject he tackles; that is why we reproduce sundry recent remarks of his on the metallurgy of copper. To write well on any subject one must know a good deal about other subjects, otherwise the writing may have the necroscopic character of a catalogue. We found that Mr. Browne's text was much too good to require any editing, but a sprinkling of hyphens helped to make it clearer. Whether the service of hyphens in technical writing is disdained by Mr. Browne or by our friend Mr. H. Mortimer-Lamb, the editor of the Canadian Mining Institute, we do not know, but we commend the matter to the attention of both.

COMMENT appears in the non-technical papers concerning the issuance of statistics for 1915 by the U. S. Geological Survey at the beginning of 1917, it being argued that this misleads people into supposing that the figures refer to 1916. Apparently our contemporaries are unaware that the final review for 1915 and the preliminary figures for 1916 are issued at about the same time, because the Public Printer is over-crowded with work.

YVES-GUYOT, the French economist, has expressed the belief that a rise in the price of all raw materials and manufactured articles will follow the ending of the War. After the Crimean war, which ended in 1856, there was a marked increase in the cost of metals; after our Civil War, in 1865, many of the metals rose in value for several years, despite a decline in wheat and cotton; after the Franco-Prussian war of 1870 the index number of iron rose from 87 to 141 in three years and the value of other metals was enhanced. The re-construction after war, and the postponed construction also, is a large factor in stimulating a demand for the metals.

SPEAKING of delirious trimmings, we note a sophomoric editorial in one of the two San Francisco morning newspapers that victimize this community. It relates to the ore of the Loretta mine, near Bishop. We quote as follows: "Our silicates are said to average 5 per cent, which is now well above the average for copper mining of all classes in America, but, while the dry, the wet and the electro-metallurgical methods have been successful in treating the sulphuretted compounds, the oxides and carbonates, each has presented problems when applied to our silicious formations." The writer of this flapdoodle evidently got hold of two or three technical terms that he did not understand and made a verbal salad of them. Presumably the average reader of the newspaper thought he was receiving scientific information, but it was as delusive as the record of suburban trivialities that loom so large in the daily history of events as furnished to us by an irresponsible local press.

AT Columbus, a city a few miles north-west of Galena and Baxter Springs, mining towns in south-eastern Kansas, prospecting by drill is about to begin in search

of zinc and lead ore, under the impression that the ore-zone underlies that part of the country. The undertaking is in the hands of the business-men of the town; they have organized the Columbus Development & Mining Co., with a capital of $10,000. This company consists of 40 members, each of whom has agreed to subscribe $240—$20 in cash and $20 each month for 11 months. This is a safe and conservative method of exploring and developing the resources of any region where there is a possibility of discovering mineral by intelligent prospecting. It is not always easy to interest outside capital in local exploration; realizing this, the wide-awake business-men of Columbus are wise in undertaking the job themselves. Their courage is deserving of reward, although a careful geological investigation by competent men should first be made to determine whether or not their scheme is one possessing the elements of success.

PENNY postage is the subject of an active propaganda. We sympathize with any effort to facilitate human communication, but we note that the campaign for a reduction of ordinary letter-postage is accompanied by the proposal to establish a zone system of rates for second-class matter, which includes periodicals of nation-wide circulation. For distances up to 300 miles the postage on second-class matter is to be 1 cent per pound, between 300 and 600 miles, 2 cents per pound of printed matter; between 600 and 1000 miles, 3 cents; 1000 to 1400 miles, 4 cents; 1400 to 1800 miles, 5 cents; and over 1800 miles, 6 cents per pound. At present the rate is 1 cent per pound across the whole length and breadth of the country; the increase therefore to 6 cents, to be paid by magazines and journals coming from New York or Boston to the West, would be prohibitive. The impost would not affect us heavily because the larger part of our clientele lives within 1000 miles from this office, but it would kill many national magazines and place a confiscatory embargo on a big industry established under the law and entitled to just treatment from the legislature and from the community. Any such rates on periodical literature would be a blow to education so stupid that we refuse to believe that the proposal will be sanctioned by Congress.

AT the recent annual meeting of the Minerals Separation in London, Mr. Francis L. Gibbs, who acted as chairman in the absence of Mr. John Ballot—then at New York—made sundry references to the legal victory won by the company in the Hyde case. He stated that the licensees of the company in the United States treated 11½ million tons of ore and paid $700,000 in royalties during 1916. That indicates an average royalty of about 6 cents per ton. He also stated that "the very numerous infringers" treated 13½ million tons during the same year. As to the taxation of the 'infringers,' he said: "It is, however, unreasonable to suppose that those who in the future will control our American interests will charge those who have been infringers of our process the same exceptionally favorable terms which were granted to large users like the Anaconda Copper Company before our patent position was established. We shall not, you may be sure, act otherwise than reasonably and equitably even toward infringers, but it is obvious that those who for the past three years have been making enormous profits by the unlawful use of our process must be prepared to hand over to us at least a considerable proportion of these profits. It is estimated that by means of our process these infringers have made profits of more than £5,000,000 [or about $25,000,000] beyond those which they could have made without our process, and by the American law we are, I believe, entitled to claim the whole of the excess." The report of the meeting in the *Financial Times* says that these remarks were received with "laughter and applause." The sense of humor is not dead in London.

A Superintendent of Mines

Mining is full of romance, but much that passes for such is tawdry fiction. The accidental discoveries of rich ore made by ignorant men to whom wealth brought merely the opportunity for unlimited debauchery are often allowed to masquerade as romance and the piling of millions by unscrupulous gamesters is not infrequently glorified into masterful finance. In this issue we publish an interview with a real miner and in the course of that interview he, John H. Mackenzie, gives us the outline of an adventurous career. The story is truly romantic because throughout there is disclosed the development of character and the growth of natural abilities that were put to useful purpose, culminating in wealth—of course—but also in things much more difficult to win—the reputation for engineering skill and the goodwill of his fellow-men. From the boy that ran away to sea and then penetrated into the lumber camps; from the youth that heard the call of the West, and the resolute man that braved the perils of the Klondike rush, we see emerge the captain of industry. From his father, who was a mechanic—"and a good one"—he inherited some liking for machines and the working of them, for he himself was a good mine-mechanic before he was a miner; he became an efficient timber-man and an expert pump-man, and through these fundamental experiences he learned to understand the more complex machinery of the mine and mill, so that in early manhood he was well equipped to direct the multifarious operations of a big enterprise. We are not of those that believe that every graduate student in mining engineering should devote several years to manual labor underground, simply because we know that many youths have not the robust physique—the toughness—necessary for the performance of such work without at the same time dulling their mental faculties, but we are among the first to acknowledge that if a young man has indeed got the spirit and the stamina to undergo this severe training he will emerge a more capable leader of men. Mr. Mackenzie underwent such a training and in consequence of it he acquired a thorough knowledge of basic operations underground; he had the nerve and the strength to go

through the hard grind of physical labor and of junior supervision, thereby gaining a closer understanding of the realities of mining work than is the portion of the young man that graduates to superintendency or management from the assay-office or the survey department. Few, if any, of those at the top of the mining profession have so intimate a knowledge of conditions underground. Moreover, the close contact with the drill-men, the shovelers, the trammers, and the timber-men has given him an appreciation of the human factor, which is at least as important as the mechanical. That was demonstrated in his successful handling of the strikes at Goldfield and at Rossland. He obtained 'bedrock' experience early and, as he says, he has "been getting it ever since."

When he went to New Mexico and the Indians stood in the way, he did not return, but "kept going." When only 23 years old he sold some mining claims and first had the feeling of financial independence. His wanderings in Arizona, New Mexico, Nevada, and Montana did not lead anywhere in particular, but the engineering done on the water-works at Eureka gave him a reputation as a pump-man and led to his first charge of a mine, near Deadwood. Soon came the lure of Cripple Creek and the meeting with Stratton. That was a decisive event in his life. As that versatile poseur Thomas W. Lawson has said: "Fate hangs no red lights at the cross-roads of a man's career." Stratton stood at the right turning, and from the moment when Mr. Mackenzie was engaged by him as superintendent of the famous Independence mine he never looked back. The story of the discovery made by Stratton is in accord with our knowledge of the facts and quite different from the meretricious tale that reporters and others concocted when once Stratton became a millionaire. Those Cripple Creek celebrities were an unlovely lot, but Stratton knew how to be generous and the story of his dealings with Mr. Mackenzie does honor to his memory. The squabble between the first owners of the Portland is not enchanting and the use of revolvers only provokes a sarcastic smile, for these antics of the directors of a big mine were childish and stupid. A touch of the fresh strong air of the Far North comes across the page as we read of the expedition to Dawson and of the journey by dog-team from Skagway. Mr. Mackenzie early realized the effectiveness of using steam, instead of wood-fires, to thaw the frozen gravel, and he capitalized his acumen to the tune of $50,000, by collecting the necessary equipment and then selling it to the men 'on the creeks.' Among his qualities is the ability to get at the bottom of things, a thoroughness of method that is scientific. He has applied this method to affairs other than mining, for his ranch and vineyard at Marysville have been made profitable. Such success is rare among those that turn from the drill to the plough, even for relaxation. Next we come to the Mariposa grant. Many of our readers will be keenly interested in reading Mr. Mackenzie's remarks concerning the southern end of the Mother Lode region. Mr. Edward H. Benjamin is now in charge of mining operations at the old Princeton mine, in behalf of Mr. Hennen Jennings, who is a strong believer in the possibilities of successful exploitation in this famous tract of mineral country. While the association with Stratton proved a turning-point in Mr. Mackenzie's career, it is probable that the most important event was the formation of a working partnership with Messrs. F. W. Bradley and Mark L. Requa. Together these three engineers founded the Nevada Consolidated copper enterprise and together they fought against the financial legerdemain by which the Cumberland & Ely claims were used to mask a tricky deal. The Goldfield chapter is full of lively doings, for, as manager of the principal mine in that district, Mr. Mackenzie had to face a bitter strike and check systematic ore-stealing, besides which he became engaged in the rapid building of a big mill and the working of extremely rich and equally erratic ore-bodies. His ability to hold the confidence and to guide the policies of two such unlike men as Messrs. George Wingfield and W. H. Crocker bespeaks a knowledge of men and a tactfulness that is not all confined to the diplomatic service. The reader will note what he has to say on the labor-union and collective bargaining. He is much too enlightened to evade the issue raised between capital and labor, or to suppose that the 'right' of the wage-earner to organize is to be met by the employer's 'right' to refuse recognition to such organization. That does not mean, however, that he has any use for the anarchistic kind of conspiracy typified by the Western Federation of Miners. He approves Mr. Albert Burch's plan to aid young Americans in obtaining instruction while working at mines; in this and in kindred matters of management he exhibits a humaneness that we know to be no affectation. As to the Alaskan mines and sampling —that is a subject much too big for passing comment. We would like Mr. Mackenzie and Mr. Bradley to follow their excellent report on the Alaska Juneau by writing a paper on the subject of sampling big bodies of low-grade gold ore, but the trouble is that those that know about these matters are disinclined to write on them. To such broad-gauge men, however, the public service performed by such a writing ought to be a real inducement. And so we leave our 'superintendent of mines' actively engaged in big-scale digging, of gold at Juneau, of tungsten at Atolia, and of other metals elsewhere. The interview will be read with pleasure beside many a camp-fire and cabin-stove, for John H. Mackenzie has spread his friendships all over the West. A man of engaging personality, of unaffected good-fellowship, and possessed of the saving sense of humor, he has made friends from the sturdy timber-man stepping into the cage for his day's shift, to the 'malefactor of great wealth' ensconced in the soft upholstery of a limousine gliding over the asphalt toward Wall Street. His success has pleased all of them, for, by birth a Canadian and by life an American, he is the kind of true democrat that socially knows no superior and likewise no inferior. Mining still offers a career to talent. It affords great chances to those that work hard and 'make good.' That is the moral of this story.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Grinding-Mills at the Inspiration

The Editor:

Sir—I was interested in reading the letter from Mr. Van Winkle published in your issue of January 6, criticizing Mr. Cole's discussion on the same subject appearing in the issue of December 9. I was, however, at a loss to understand how Mr. Van Winkle, after carefully reading Mr. Cole's comments on the subject could say, "Does Mr. Cole think that the mining and milling fraternity will accept results as 'conclusive' from him or any one else in which the mills are operated in two separate plants and where the Hardinge mills are crushing in two stages and the Marcy is doing it in one?" Personally, I cannot conceive of a more conclusive comparative test than that contemplated at the Inspiration and referred to by Mr. Cole. The ore to the mills working in competition will come from the same mine and will be drawn to the two different mills from the same bins after the same preliminary crushing; the fact that the Hardinge mills will be used in tandem or two-stage reduction while the Marcy mills will be used in single-stage reduction will in no wise affect the conclusiveness of the result if the tests are extended over a period long enough to obtain reliable data as to maintenance.

Mr. Van Winkle further states, "I am sure the mining public would like to know the difference between the real Hardinge ball-mills that are now being installed at Inspiration and the Hardinge mill equipped with 11 tons of steel balls that was used in competition with the Marcy mill during December 1914 at the Inspiration test-plant." To the best of my knowledge the Hardinge mills in these tests were charged with pebbles and were used as re-grinding mills against tube-mills and not in direct competition with the single-step Marcy mill.

I cannot agree with Mr. Van Winkle when he expresses a doubt as to the contemplated experiments on ore reduction adding materially to our knowledge of crushing, for to me the work of the Hardinge mills at Miami, taking an initial feed of ⅝-inch size and crushing to the required fineness in two-stage reduction; the comparative grinding tests at Inspiration of the single-stage Marcy mill working in competition with the Hardinge two-stage reduction, each mill receiving the same size of feed and reducing to the same fineness, will be of exceptional interest. The work of the Symons disc-crushers at the New Cornelia Copper Co.'s plant taking a 3½-in. feed and reducing to ¼-in. size and the tests of using balls instead of rods as a grinding medium in the Marathon mills to determine by which method the ore is best prepared for flotation, should also be of more than passing interest.

The above experiments are broad in scope and taken as a whole they cover the field better than any previously tried. The data obtained from these experiments should not only add materially to our knowledge of crushing but should also bring about a decrease of operating cost.

HENRY HANSON.

San Francisco, January 10.

Misfires

The Editor:

Sir—I have read 'The Prevention of Misfires,' by Mr. E. F. Brooks, which is very good. He gives more causes than most people could imagine existed for misfires; they cause annually a very considerable loss, and anything we can do to curtail that loss will save money and lives. One cause of misfires recently brought to my attention is the absorption of dampness in the end of the fuse, before the cap is put on; frequently you will hear the miners say it was a 'bum' cap, when the cap is all right. The fuse burns to within an inch of the end, and goes out because dampness has penetrated that exposed end. This can be avoided by reversing ends or cutting off an inch or two of the exposed end.

JAMES ROSS.

Towle, December 21.

The Small Shipper and the Smelter

The Editor:

Sir—We note in one of your recent issues that you invite the small mine-owner to write up his experience in shipping small lots of ore to the smelters. At different times this past summer we have shipped small amounts of ore to a certain smelter, and in every case but one our assays have been away yonder over the amounts we received from the smelter, and in that one case—the largest and highest-grade shipment we made—our assays showed the value of the lot to be slightly over $1100, for which amount we registered the shipment at the express office, and the smelter returns amounted to $950. This shipment weighed 380 lb., and we have since learned that assays made by an independent assayer on a fair sampling of the ore showed values to the extent of $10 per pound. And another thing, shipments made through the express company invariably realized nearer our assay

than did shipments made by freight. We wonder if the railroads and smelters don't have some kind of a 'gentlemanly agreement'?

Now, we have good reason to believe that our assays run low, as we have checked pulp with other assayers and in every case our results were under those given by custom assayers. We admit that our furnace is not of the best, and perhaps we lose some values "in the perfumes" as one mining 'expert' put it. Our last shipment of ore, over the railroad, as freight, seemed to us an especially raw deal. It was almost straight hematite, hand-sorted to a clean product, and contained an appreciable amount of coarse gold. Our assays on a fair sampling showed over $500 per ton, and there was 420 lb. of it. Keeping in mind our uniformly low results in assaying, we figured on from $100 to $150 in the lot, but the smelter returns came to $42, with absolutely no mention of metallics, and we are confident we could have amalgamated $40 or $50 from that ore by grinding and panning here at the mine, as we had previously ground and panned several hundred pounds and know almost exactly how much gold there is in that hematite stuff. Our object in shipping it was to save the trouble of grinding it and to avoid the loss of gold in the tailing. Also, the smelter deducted 6.4% of the 420 lb. as a moisture penalty, though when we sacked the ore here it was dry and dusty and was delivered to the railroad in that condition—6.4% on a dry ore. We wonder how they have the nerve, when it is well known that the mechanical filter-press dries a sloppy mud in a few minutes to a product containing from 8 to 12% moisture, and in the Editor's recent article on the Britannia mine, in British Columbia, he speaks of concentrate drained to an 8% product—a damp, if not actually wet material, several degrees removed from a dusty ore.

Now, to conclude, we shipped the ore and received a check to cover same at the smelter's valuation, and we shall have to be satisfied, but you can bet that aggregation of robbers won't get any more of our ore. We'll get a beer-keg and cyanide it, and thereby save all of the values.

LOVEJOYS.

Unity, Oregon, November 27.

How About Contributory Negligence

The Editor:

Sir—Laws having for their object the protection of workmen are becoming drastic and numerous, but among all these there is a conspicuous absence of any law providing a penalty for the carelessness, or contributory negligence, as it is legally termed, on the part of the workman himself. Of the many accidents occurring in mines the greater number is due in some measure, and not infrequently wholly, to the carelessness of the workman himself. Too frequently he is guilty of contributory negligence. He is prone to overcrowd the skip, or cage, if there is no one in authority to restrain him; he will tamp holes with the iron spoon, if no one is watching, because it sometimes is a little easier, especially in a deep hole, and therefore more quickly done. He will often take evident risks in working down ground because he does not find it convenient to put in the necessary timbers as soon as they should be placed, preferring that someone else do it. He has been known on occasion to push a loaded car carelessly into the shaft at the station without first looking to see whether or not the skip was there to receive the ore. True, this last is of rare occurrence, as in most well-managed and properly-equipped mines ore-pockets are provided beneath the levels at the various stations into which ore or waste may be dumped, to be drawn into the skip at some later time when convenient, but in small mines there are often levels where no such ore-pocket is cut, and the ore is dumped directly into the skip—but it is not customary to dump the ore into the shaft when the skip is not there to receive it.

Mining always involves the element of danger—it is inherent—but the miner becomes so accustomed to it that, after a time, he ceases to give to the usual evidences of danger the serious consideration they require. Old timers are just as liable to injury as those who are comparatively inexperienced. The newer men, not yet callous to the dangers of their calling, and remembering the slogan 'safety first,' give more prompt heed to evident danger, whereas the same sign may be neglected by those long accustomed to underground work. If the laws provided a penalty for many of the forbidden things that workmen do about mines, things that are forbidden by the mine management and by common sense, if not by law, there no doubt would be fewer accidents, for often it seems as if the average miner holds in greater dread the possibility of a fine of a few dollars, for some infraction of a rule, than possible injury or the loss of his life due to breaking this very rule.

In this connection it is interesting to note that the United States Circuit Court of Appeals recently decided in the case of Macauley *v.* Alaska Gastineau Mining Co. that a miner working in a raise where the company had taken all reasonable precautions to insure his safety, assumed the risk of being injured through the falling of rock, in barring-down after blasting. It is also interesting, even gratifying, to observe that the Accident Commission has not always the last word in such cases.

MINE OPERATOR.

Jackson, December 11.

THE JANUARY ESTIMATES of shipments of iron ore from the Lake Superior mines during 1916 are 75,500,000 gross tons, compared to 55,493,100 tons in 1915, according to Ernest F. Burchard of the U. S. Geological Survey. Not only are these record-breaking figures, but the ore sold for $178,935,000, an increase of over $77,000,000 compared with 1915. Ore in stock at the mines approximates 10,486,000 tons, compared with 13,748,000 tons in 1915. Production of pig iron also made a record in 1916 with a total of over 39,000,000 gross tons, compared with 29,916,213 tons in 1915.

Platinum in California

By E. F. Brooks

The present high price of platinum has resulted in many inquiries concerning this metal, and particularly where it may be found.

Platinum is produced in northern California and southern Oregon, where it is associated with placer gold. In California it is found from El Dorado county northward, in the districts where serpentine is abundant. It never has been found in this State associated with any other rock than serpentine, and this has come to be considered as the formation in which platinum should be sought. Platinum occurs naturally as an alloy, being combined with iron, iridium, osmium, rhodium, and palladium. The osmium content is generally the greater, being in northern California 1 to 2%.

Platinum does not amalgamate with quicksilver but owing to its great density it is easily arrested by riffles in the sluices. Several years ago, when operating a hydraulic mine at Trinity river in northern Humboldt county, I found platinum more abundant there than in any other district with which I was acquainted, the platinum constituting about 10% of the entire output of the mine. Prior to the commencement of our work at this mine, there had been no mining done in this locality by the hydraulic method, except some small operations by old-timers along the river. They observed the platinum mingled with the gold when cleaning-up and separated it as far as practicable and threw the white metal away, not knowing its value. They regarded it as a nuisance, as it is difficult to separate from the gold, which was in small flat scales and caused some loss of the gold in panning if the greatest care was not taken to prevent it, particularly where no quicksilver was used to amalgamate the gold, and even then it required an experienced panner to effect a close separation of the two metals. As a natural consequence some platinum usually remained with the gold, which was generally sold in small quantities from day to day to local storekeepers. These buyers penalized the miners for the platinum with their gold-dust, so the presence of the more valuable metal resulted in an actual loss instead of an additional profit. Whether the storekeepers received anything for the platinum, I do not know.

Our mine was operated with giants having a 6-in. nozzle under a 300-ft. head; the gravel was free and easily washed, containing few boulders that required bulldozing. Although the gravel was low-grade, the operation was profitable, as the cost of mining did not exceed 2c. per cu. yd. using a 3½-ft. flume set on a 7% grade.

The gold was fine and in thin flakes, though not 'scale' gold. It had evidently been transported from a great distance. The bedrock was slate, but a broad belt of serpentine lay just above the mine, and over this the gravel must have passed. Doubtless the serpentine was the source of the platinum associated with the gold in our mine.

There are thousands of acres of gravel in this district, all of which carries some platinum and most of it enough gold to pay by hydraulicking under experienced management. It is mostly on the public domain and subject to mineral location. The higher ancient channels, some of them 1000 ft. higher than the modern streams, are generally the richer, carrying coarser gold. Some of these channels are admirably situated for hydraulic mining and there are no restrictions on the hydraulic method of mining in this region as the streams are not tributary to the Sacramento valley, but run directly to the ocean. The greater part of the expense necessary to the opening of a mine here will be the creation of reservoirs and the digging of ditches. The building of flumes, pipe-lines, and equipment of camp would be about the same as elsewhere.

GOLD PRODUCTION. In a compilation prepared by the foreign trade department of the National City Bank, some interesting facts are given regarding the world's gold production. The output of this precious metal in the last 25 years equals the total for four centuries immediately preceding this period, and the production of silver since 1878 also equals the output of the 400 years immediately preceding 1878. The gold currency of the world has doubled in the last 20 years, and silver has been reduced one-half in that time. The total production of gold from the discovery of America to the present time is placed by the National City Bank at $16,500,000,000 in value, and the production of silver at $15,500,000,000 in coining value. The gold money of all countries of the world, for which statistics were available in 1896, reached a total of $4,144,000,000. On January 1, this year, the aggregate was $8,258,000,000. In 1896, the silver money of these same countries amounted to $4,237,000,000, while in 1916 this had shrunk to $2,441,000,000. The 'uncovered paper' money—not completely protected by gold—of the countries in question was placed in 1896 at $2,558,000,000, and in 1916 at $8,583,000,000. The production of over $8,000,000,000 worth of gold in the last quarter of a century, compared with $8,000,000,000 in the preceding 400 years, has taken place chiefly in the last decade. Down to 1885, the world's gold output never reached as much as $100,000,000 annually. In 1896, it was a little more than $200,000,000 and in 1903 it for the first time exceeded $300,000,000. In 1906 the mark of $400,000,000 was crossed. The chief gold producing countries of the world are South Africa, the United States, Australia, Russia and Canada, while the chief silver producing countries are the United States, Mexico, Canada, and Peru.

FIRST PRODUCTION of lead and silver from the mines of the Coeur d'Alene was made in 1885-'86. It mostly came then, as ever since, from the Bunker Hill & Sullivan mine.

HEROULT electric-steel furnaces to the number of 80 are now operating in the United States and Canada. On January 1, 1916, there were but 43.

John H. Mackenzie: A Superintendent of Mines

An Interview. By T. A. Rickard

Mr. Mackenzie, you are a native son?

No; I am a Canadian, born at Toronto, Canada, on the 24th day of May 1858.

Was your father engaged in mining?

No; my father was a mechanic, and a good one.

What made you take to mining?

The lure of the West, and the high wages.

What preparation did you have?

I had some schooling in mechanics and engineering—not a college course—in the high-school at Goderich, Ontario. When I was 13 years of age, I ran away to sea. I went as an ordinary seaman on a sailing vessel called *The Mechanic,* leaving the port of Detroit for Chicago; after that I made voyages from Chicago to Montreal, and from there to Liverpool and London.

How long did you stick to the sea?

Three years only. I decided that the sea did not offer me a career; I saw no prospect of advancement.

What next?

I went into the lumbering business at Muskoka, in Ontario 200 miles north of Toronto. My work was scouting for timber, measuring and keeping accounts of the timber purchased for Gordon & Co. I had two years at that, learning to take care of myself in the woods. I also learned the difference between good and bad timber, besides having some experience in the wild life of the river.

It was a pretty tough life?

Indeed it was. That was why I left it when the novelty had become well worn.

What date was this?

I quit lumbering in the spring of 1877, and in the fall of the same year I came west to Eureka, Nevada.

What brought you to Nevada?

Reports of men that had returned from there telling of the great camps of Virginia City and Eureka, which, at that time, were at their best.

Eureka, I suppose, was producing a great deal of silver-lead?

Yes; and gold also, for the surface ores contained nearly as much gold as silver.

Did you get a job?

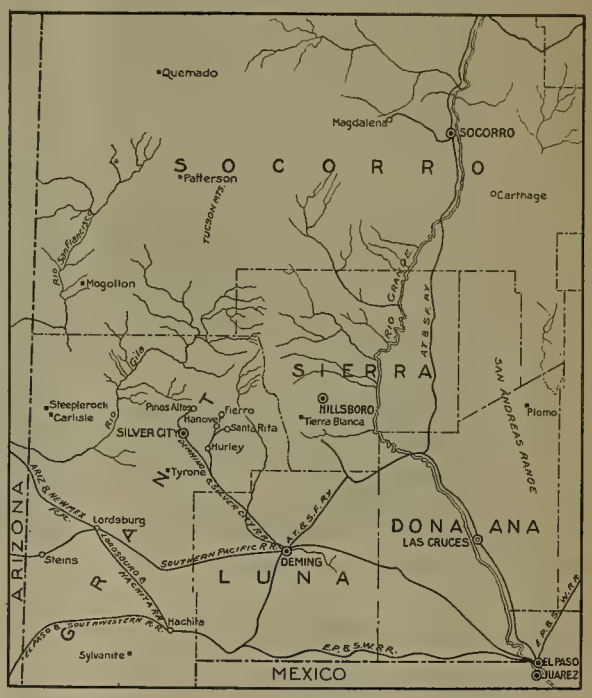
I did. I went to work in the Jackson mine, as a miner, receiving $4 per day for a 10-hour shift. The work was done by hand, double-hand, that is, using both hands on a hammer while one partner held the drill. Another interesting point is that they were using black powder, although 'giant' had been introduced, and was being used in some of the mines at Eureka.

Who was the manager of the Jackson mine?

William Shaw. He had been manager of the Eureka Consolidated, and he was owner of mines at Eureka until he died.

You were there for some time?

I was there for three years. The second year I worked as a timber-man, and the third year I was pump-man part of the time, and timber-man the rest. In the third



MAP OF NEW MEXICO.

year, when I was 23 years old, I was in charge of the timber-gang.

So you obtained some bedrock experience?

Yes, and I have been getting it ever since.

Do you recall any of your friends at Eureka at that time?

I knew Dr. Zeile, whose name is given to a well-known mine on the Mother Lode, and Hank Donnelly, who was a famous superintendent at Virginia City; also Charlie Canfield, who died three years ago, and was a big operator in oil, associated with E. L. Doheny. Canfield was shift-boss when I was timber-man in the Jackson mine. I also knew Tom Reed, superintendent of the Eureka Consolidated mine and smelter, and your uncle, Reuben Rickard, who was then superintendent of the Richmond; also John A. Porter of Denver. In fact, my next move

was due to Mr. Porter, for he engaged me to go to Colorado as timber-man in the Aspen mine at Silverton.

What sort of a mine was that?

Native silver ore; the vein was worked by adits entirely, the ore being treated locally at the Greene smelter. They charged from $75 to $100 per ton for smelting, not to mention other deductions, so that the smelter made money, and even the mine, because the ore used to run from 150 to 300 oz. silver per ton.

You did not remain timber-man long, I suspect?

About eight months. The Black Range excitement broke out in New Mexico, and I stampeded, going on snow-shoes to Durango, then by pack-horse to Santa Fe, and from there down the river to Socorro.

What did you find there?

Many promising prospects; but I did not stay, the danger from the Indians being greater than the prospects of making money, although Chloride Gulch became quite a camp afterward.

When did you return from New Mexico?

I did not return; I kept going. I went down to Tombstone, Arizona, and into the Chiricahua range, where I prospected for silver and located some silver-lead claims. This was the spring of 1881. I spent some time in several mining camps in New Mexico, such as Silver City, Georgetown, Santa Rita (which is now Chino), Shakespeare—by the way, Henry C. Callahan was there at the time, and so was Doheny.

You did not find anything good?

No, but I sold some claims and made a small stake, selling five claims for $5000, which seemed a lot of money to me then. With that I went back to Tombstone, in the fall of 1881, the year in which Garfield was shot. At Tombstone, I was ill for a time with rheumatism, and then I came to San Francisco, where I regained my health.

By this time you were only 24, but you were more than a sophomore in the college of experience?

I thought I knew a great deal more than I really did. I found afterward how little I knew at that time, but I was full of confidence and ambition, and I had become tremendously interested in the work of mining.

What was your next step?

I went back to Eureka a second time. The Eureka Consolidated was putting down a large new shaft, and erecting a big plant of hoisting machinery and a large hydraulic pump. I went to work for the company, taking charge of a gang of men engaged in installing the new machinery. After the machinery was in place I had charge of the pumping plant from the time it started in the fall of '82 until it shut-down. For two years they kept sinking the shaft and fighting the water, so that I was fully employed and obtained some valuable experience—some of the best experience that I have ever had. The mine became flooded, and the camp practically idle, so I took a lease on the Hamburg mine above the Dunderberg, north of Eureka.

How much money did you put in?

We put in very little money, but a lot of work. We made some money, shipping our ore to the Richmond & Eureka Consolidated furnaces, and then cleaned up. From there I went to Butte, Montana, which was then, in the fall of 1884, on the boom.

What did you do at Butte?

I worked as timber-man for Alfred Wartenweiler, who was manager of the Lexington mine. After a few months I took a lease of the Lavina mine at Burlington and the old Silver Bow 10-stamp mill. I was in partnership with Neil McSherry. We made some money, but the vein played out in depth, and, owing to the excessive flow of water, we could not afford to prospect further. I then went to work for W. A. Clark in his concentrator at Meaderville, and put all the machines there in shape. I was there about four or five months. I knew many of the old-timers, Patsy Clarke, Mike Carroll, the famous superintendent of the Anaconda, Daly's right-hand man. I also knew Jim Murray, besides Marcus Daly himself, but only casually.

What sort of a place was Butte then?

At that time the roasting was done in heaps in Silver Bow flat, and the air was loaded with sulphurous smoke, so that at times people on the street could hardly find their way. The Lexington was down only 450 ft. and the Anaconda was only 800 ft. deep. Silver was an important part of the output, in addition to copper.

From Butte you went whither?

The smoke made my throat so sore that I decided to seek a purer air, and went to San Francisco, remaining there about two months. I was offered a position as foreman of the Jackson mine, the one in which I had first worked. I accepted; that was in '86.

You ran the mine for how long?

Two years. I then leased what was known as the Ruby Hill Water-Works, from Walter Harrub, a famous character in the early days of Nevada. I ran the waterworks for two years, but you must not think that there was no mining connected with this job; the tunnels for tapping the water were always caving, so that I was kept busy maintaining them in proper repair. Eureka became very dull again, so in 1891 I went to the Black Hills, in South Dakota.

Did you have an appointment?

Yes, with Franklin R. Carpenter. I had obtained some sort of a reputation as a pump-man and a miner experienced in handling water, thanks to my work at Eureka. Dr. Carpenter ran the old Delaware smelter and had several mines in the district, among the number being the old Oro Fino, which was full of water at this time. They were trying to pump it out. It was about 12 miles from Deadwood. I was superintendent of that property for about two years. The price of silver went down so much in the crash of 1893 that work was stopped.

It seems to me, Mr. Mackenzie, that you and I are in

agreement in one respect. I used to think that a young man could always get all that there was to be learned at any one mining camp in the course of two years. It seems to me that your periods were nearly always two years.

Yes, I made it a point to never stay longer than two years in one camp.

On leaving the Black Hills, where did you go?

I had heard of the Cripple Creek excitement, and went there, meeting W. S. Stratton, the discoverer of the Independence. I found him prospecting on the surface of Battle Mountain. He told me about his discovery; it seemed to be interesting. He wanted to know if I knew how to run a mine; I told him that I could, and without any further recommendation or acquaintance, he engaged me on the spot. I gave him references, but he never made use of them. He had had six superintendents in the previous three or four months.

That was the time when I first met you?

Yes. I remember a visit that you made with Mr. Tom Stearns to the mine in December '93, when Cripple Creek was having its first boom. The Independence shaft at that time was only 100 ft. deep, and the Washington shaft was 60 ft. deep, with a tunnel uniting them. We were raising the ore with a whim, stoping above the connecting level, and shipping the ore to Denver. I restarted work on the Independence shaft, and kept on sinking it until it was 600 ft. deep. The Independence vein proper was in granite and the shaft was situated near the contact between the granite and the porphyry, hence the vital question at that time was whether the vein would continue into the porphyry. When I first came the ore was averaging five to seven ounces per ton for a width of five to seven feet.

What smelter rates did you pay?

I think on 5-oz. ore the smelter and freight rates combined came to $15 per ton.

What sort of a man was Stratton?

A man with a keen mind, but not well balanced. In business he was liberal and fair, but suspicious; he trusted very few people, changed his mind often, and did not understand handling the large sums of money that he was making not only out of the Independence, but also out of the Portland, of which he owned one-fifth. He was very charitable. In his investments he was often foolish, and a great many people took advantage of him.

MAIN STREET OF VIRGINIA CITY, NEVADA.

He was not a man of any technical training?

No; he was a good millwright, and had prospected quite a lot, especially around Silverton. His finding of the mine was a matter of luck. He was prospecting on the sunny slope of Battle mountain and he saw the outcrop of the Independence vein, but it looked very much like granite. Several other people had seen it and concluded it was nothing but decomposed granite. All of them passed it by. Stratton himself found that the loose porphyry-rock on the hillside contained gold, but he could find no vein. Finally he chipped off a piece of the granitic outcrop and looked at it through a magnifying glass, detecting some rusty gold. Thereupon he broke some more pieces and had them assayed at Colorado Springs. The sample contained 19 oz. gold per ton!

So you had the pleasure of starting the development of one of the big mines of the world. Did you remain long with Stratton?

Three years. Then I went on a vacation and while I was away the meeting of the Portland directors took place. They were having trouble with water in the Port-

land shaft, and at the meeting of the board, the directors, who were quarreling, agreed to offer me charge of the mine. I accepted. The offer came to me by telegram while I happened to be in San Francisco on my vacation. I returned next day, as they accepted my terms right away. I took charge of the work at the Portland for just about a year.

Then you knew James Burns and John Harnan too?

Very well. At that time Jim Doyle, another owner, and Jimmie Burns were at dagger's points and when they came to the directors' meetings—I was also a director—Doyle would come with the handle of a six-shooter sticking out of his coat-pocket, and Jim Burns was supposed to carry a gun in his hip pocket. It looked like a battle every time they met; I always expected that one of them would kill the other, but no gun-play ever followed, I am glad to say, for my life, incidentally, would probably have been jeopardized also. Stratton used to sit back in the corner with his hand on the gun in his trousers' pocket. Yes indeed those were lively times! Stratton himself used to laugh at Doyle and Burns; he was absolutely fearless. The affair ended in a long-drawn litigation and in Burns getting the control, which he afterward lost to Howbert and some of the others.

Why did you leave the Portland?

On account of these rows and bickerings. My engagement was only for a year, so that when the year elapsed, I went to the Yukon. That was in 1898, the year of the big stampede. Stratton was interested with me in the venture. I took six assistants with me, and sent them ahead over the ice to Dawson, following them myself in the spring of '99 on the old steamer *Leelannaw*. She was torpedoed recently by the Germans.

That must have been an exciting episode.

It was; a big mob of people was going to the diggings. Most of them did not know what they were going to do. I went by water to St. Michael, and up the Yukon to Dawson, so that I missed the horrors of the White Pass. Arriving at Dawson, I saw a great crowd of people camped on the river, a town was being built rapidly, warehouses were going up—the usual excitement of a mining camp—but I did not stay long in Dawson. I went out on the creeks, and stayed there for nearly a month, tramping around and investigating. Finally I bought some claims on Bonanza creek, between Fox and Monte Cristo gulches, and extending down to Bonanza. I also started a survey up the creeks, with the idea of building a railroad. I sent men among the diggers to check off the amount of freight that was coming in, to find out what it was costing. The profit to be made on 60-days freight would have paid the cost of a narrow-gauge railroad. I took the plan to Ottawa, but I could not get a charter without giving the greater part of it away to political grafters. It was two years before we got the charter, and by that time the interest that was left to Stratton and myself was only 36%, 64% having gone to the Ottawa lobbyists. I regret to have to say that at that time Canadian politics was thoroughly rotten.

Did you return to Dawson?

From Ottawa, yes. I went in over the ice from Skagway with a dog-team. That was in March 1899. At that time Dawson had become more settled; they had built better trails up the creeks; the claims were being worked systematically and with intense energy. I worked my claims for two years, and then sold them at a profit of $65,000, of which Stratton was entitled to half, but he refused to take any of it, so that I got all of it, thanks to his generosity. I sold because I had decided that I did not want to live there. The winters were too cold and the work required too much supervision. Incidentally, I may say that I was one of the first to recognize the usefulness of steam-thawing and to use it. After selling my claims, I came out to Seattle and bought all the small boilers I could find in Seattle, Tacoma, Portland, and Vancouver. Altogether I got about 35 small boilers, some small hoists, thawing-tools, pipe, and so forth, and shipped them into Dawson.

You made money over that?

Yes, I cleared about $50,000 out of that deal.

Speaking of thawing, do you refer to the use of steam-points?

Yes. At first the people on the creeks used to take empty gas-tanks, the kind used for charging soda-water. They were about 6 in. in diameter inside, and about 5 ft. long, standing a pressure of probably 1000 lb. per square inch. Then they drilled dozens of little holes about ¾ in. all around them, cut off short pieces of pipe, about a foot long, welded one end, cut a thread on the other—so that they played the part of tubes in a tubular boiler—and screwed those short pieces into the boiler, then admitted feed-water near the bottom and drew steam at the top. The tank or miniature boiler was set on end, enclosed in stones cemented in mud, and a fire was built at the bottom. The steam thus generated went to the 'points,' which were steel pipes with a solid piece of steel welded at the front end so that they could be driven into the ground like drills.

What did you do next?

I went to the Mariposa grant for Wernher, Beit & Co. I had become acquainted with Hamilton Smith during a visit that he made to Cripple Creek to inspect the Independence mine. When the British financial firm purchased the Mariposa grant from the former owners, the trustees of the Alvinza Hayward and J. P. Jones estates, Hamilton Smith asked Capt. Thomas Mein to look me up, and the latter then offered me the position of manager of the grant, which included a group of five mines that had been worked in the early days by John C. Fremont.

Yes, I happen to know about that, because my grandfather, James Rickard, came to California in 1850 *to examine the Mariposa grant in behalf of the firm of John Taylor & Sons. The grant had been placed in London by General Fremont, known in romantic*

THE OUTCROP OF THE INDEPENDENCE.

history as the 'Pathfinder.' My grandfather brought a sectional stamp-mill from Cornwall, and made a thorough test, the result of which was an adverse report. Of course, at that time, the cost of mining was high, and a low-grade mine that might be highly profitable today would not be worth looking at 66 years ago.

That is true, but we also found the ore left by the old-timers very low-grade. After pumping the principal workings, we found no ore that would pay, even with present methods of mining and milling. The best ore left in the Princeton—the principal workings—assayed only $2 per ton. Our predecessors had worked out the ore that was profitable to them, and a good deal that left no margin, but after extensive development work we found good ore below the old workings.

Do you think that there is any chance of successful mining on the Mariposa estate?

Yes. I do. We sank below the lean zone, and found good ore between the 600-ft. point, where the old company stopped, and the 1000-ft. level of the Princeton. We had long and wide stopes of good ore.

How good?

To the best of my recollection it ran from $4.50 to $5 per ton. I might add that there was also in one mine, the Mariposa, some profitable ore that the old company had left because it was so hard that it could not be stoped profitably without ma-

THE INDEPENDENCE AND PORTLAND MINES, CRIPPLE CREEK.

chine-drills, which were not in use at the time mentioned.

How long were you there?

I was on the Mariposa grant from 1899 to 1901, and I left owing to the offer of the management of the Le Roi mine and the Northport smelter. The offer came to me through R. J. Frecheville. At that time Mr. Frecheville was examining the mine, and the Le Roi Mining Co. had been the victim of Whitaker Wright's operations, being indebted to the Bank of Montreal for some half-million dollars. Whereupon the bank had insisted on an examination by Mr. Frecheville, and on a re-organization of the management; so I went there in November 1901.

You found things in bad shape?

Yes. The Northport smelter had been badly handled. There was 80,000 tons of copper ore in the roasting-yard that would barely pay the cost of smelting. This had been done apparently to boost the stock. Whitaker Wright left things in a sad mess.

You would not condemn the British management of mines wholesale?

Certainly not. I have seen as many mines managed conspicuously well as conspicuously badly by English companies, and, after all, the local management at Rossland was not British. However, I do recognize the difficulty of managing a mine in the United States when the board of directors sits in London, and is wholly unfamiliar with the local conditions. The only remedy is for the directors to place authority in the hands of a competent resident manager, and they must give him a pretty free hand, otherwise he is severely handicapped by the delay in getting permission to do things, and by the uncertainty as to which individual is in control at the other end. Business that requires instant decision may have to wait for weeks.

What sort of an experience did you have at Rossland?

There was a strike on at both the mine and the smelter when I arrived there, making it rather difficult for the first few months, but at the end of a year we had paid off nearly all the debt to the Bank of Montreal, and the affairs of the company improved daily. At the end of two years, when I left there, we had about $460,000 in the treasury.

What happened then?

Then I resigned, as I wished to return to the United States.

What next?

I joined F. W. Bradley, here in San Francisco, in the work of examining and managing mines, and we continued to do that for several years. Between 1903 and 1905 Mark L. Requa joined Bradley and myself, and we did a general consulting business. At that time Requa had an option on what is now the Ruth portion of the Nevada Consolidated. Bradley and I joined him in the enterprise. All of us spent a good deal of time at Ely, and made the necessary tests, by drilling and milling, to determine the value of the property. Requa was in direct charge of this work, which led to the organization of a company, by James Phillips and W. Hinkle Smith, called the White Pine Copper Co. That was in November 1904. Out of this and the Boston & Nevada Copper Co. grew the Nevada Consolidated, which has proved such a splendid property.

You made some money out of that?

Yes, we all made money, but we had to surrender control, owing to the fact that our Eastern friends insisted on selling to the Guggenheims. Still, we did very well.

Are you still interested in the Nevada Consolidated?

No. We have gone into a lot of other things since.

What was your next venture?

I went back to the Le Roi in 1905, with R. W. Brock, of the Dominion Geological Survey, for the purpose of appraising practically all the large mines in the Rossland district, including the Centre Star, Le Roi, War Eagle, also the St. Eugene at Moyie, and the Trail smelter, for the purpose of an amalgamation planned by Sir Henry Tyler, who was chairman of the Le Roi company, but this amalgamation fell through, owing to the hostility of A. J. Macmillan, who at that time represented the minority shareholders and subsequently became managing director.

When did you become manager of the Goldfield Consolidated?

In 1907. The management was offered to me on the initiative of William H. Crocker, in association with Senator Nixon, the partner of George Wingfield in his mining ventures.

You had a lively time while at Goldfield?

Yes; four days after I arrived there was a strike called, and the whole property shut-down for a time. I was glad of the shut-down, because it stopped the stealing of ore. Up to that time the Goldfield Consolidated had only a small mill and was shipping a great deal of ore to Salt Lake, paying high railroad and shipping rates, as well as excessive reduction charges. The strike gave us time to build a mill of our own, which we did, commencing in January 1908, and finishing in December of the same year. This was a 100-stamp mill, capable of treating about 600 tons a day; afterward a Chilean mill addition was put on, and the plant was raised to 1000 tons per day capacity.

Mr. Mackenzie, you have been in charge of a great many mines, and have come in close contact with the working miner. What do you consider the main cause of trouble between the companies and their men?

The walking delegates, and the lack of co-operation between the management and the better class of their men. As a matter of fact, while I have been through three strikes, I have prevented a great many strikes by getting the better class of workmen before me and talking in a friendly manner with them, making an effort to show them that the company or its management had no desire to take advantage of them, but, on the contrary, was trying to be fair to them. Usually this kind of argu-

THE MOTHER LODE REGION IN MARIPOSA COUNTY, CALIFORNIA.

ment, especially when really true, would always be listened to with respect.

Do you recognize the right of unions to act together? In other words, for the local union to join with unions in other districts in making a demand?

I recognize their right to do so, but I do not believe it is always the best policy for either the mining companies or the unions to join large labor organizations that have nothing in common with the particular work or other local problems, but I do recognize the right of combination, and of collective bargaining. We all do it.

I take it, however, that you do not regard the Western Federation as a union within the law?

Certainly not. I do not recognize the Western Federation as a good friend of the Western miner. I do not approve of their methods of gaining their points. I do not believe that they have helped to further the just demands of our Western men. In the early days of Nevada, the miners' unions of Eureka, Virginia City, and White Pine were organized as locals, and as individual unions they gained more advantages from the mining companies than the Western Federation ever gained afterward by their methods of intimidation.

How long were you at Goldfield?

As manager I was there a little over two years. For two years longer I was consulting engineer and director, that is, until the early part of 1912.

You returned to consulting practice in San Francisco?

No. All three of us—Bradley, Requa, and myself—were so absorbed in enterprises in which we had placed our own money that we did not look for clients. However, my work at the Alaska Juneau has been of a consultative kind.

When did you get into that?

Bradley had been connected with the Alaska Juneau for many years, and in 1910 Requa and I joined Bradley in driving the new adit and other work, for which we received a block of shares out of the treasury of the company. Subsequently we, together with Mr. Crocker, purchased the Wernher-Beit interest in the Juneau property, so that we obtained control.

You made a report on the mine in 1915, *I believe?*

Mr. Bradley and I made a joint report, estimating 80 to 100 million tons of ore to be mined and milled. Given sufficient money to develop and equip the property we estimated a profit of $1,400,000 per annum as reasonably assured. On this report we sold 400,000 shares of the treasury stock, netting the company $8 per share, a large block being taken by B. N. Baruch and associates.

Mr. Mackenzie, I am going to ask you a question that

ATOLIA DURING THE TUNGSTEN BOOM.

may be difficult to answer. To what extent do you think these enormous bodies of low-grade gold ore can be sampled?

My personal opinion is that the usual methods of sampling are of no use in such orebodies. You have to carry out the test on a milling scale, that is, crush thousands of tons and take samples right across the vein, quite similar to a moil cut, and, in addition you have to take it at different levels on the orebody. We milled 50,000 tons from across the orebody lying north of the Silver Bow fault, and we based our calculations on the value of the ore north and west of Silver Bow on that mill-run. On the south-east side of the Silver Bow fault, adjoining the Alaska Gastineau property, we based our calculations on about 480,000 tons of ore that had been mined and milled during the life of the Alaska Juneau, prior to and after our acquiring control.

Can you find out the number of raisins in the cake without eating all of the cake?

No. Absolutely no. Therefore, even sampling on this scale is only an approximation, but it's as close as one can afford to go.

Of course. If you take more out, you may as well take all out, and the sampling becomes an exploitation on a large scale, and ceases to be sampling.

We are compelled to take some risks on sampling and estimating orebodies similar to those on Douglas Island and in the Alaska Gold and Juneau mines. Our calculations are based on estimates that may vary considerably when we come to take the ore out.

You have faith in the outcome of the big operations at Juneau?

I have. I believe the Alaska Juneau will earn the dividends that Mr. Bradley and I predicted, namely, $1,400,000 per year.

Have you formed any opinion about the prospects of your neighbor, the Alaska Gold Mines?

I have not been through the Alaska Gold mines for over two years. At the time of my last visit, it looked to me that they would make good on their estimates of producing a net profit of 75c. per ton. Since that time I understand that they have had some difficulty due to the hanging wall of the vein caving and mixing with the ore, resulting in reduction of grade. While they may not be able to earn 75c. per ton net profit, I believe they will be successful in earning a substantial profit—a profit that will justify them in their original investment on the property.

By the way, Mr. Mackenzie, you are one of those that profited from the rise in tungsten, I believe.

Yes, I have an interest in the Atolia mine, together with my friends, Mark Requa, Fred Bradley, Baruch, Stent, and Voorhies. While the price of tungsten was soaring, we made some nice dividends.

Are the technical operations interesting?

The Atolia ore is scheelite associated with quartz in a fractured zone through the granite. The vein is faulted and twisted so much that it is very difficult to follow it. The interesting thing about tungsten is that none of the producers are using the soluble treatment of it. The Germans have been doing it for years, and we are planning a soluble-treatment plant and refinery, and have decided to erect one at Atolia. At the present time we mine the ore and transport it to a mill that will treat about 65 tons per day, crushing and concentrating in a manner similar to lead and copper practice, and making a concentrate containing from 50 to 75% of scheelite. We ship it to the Eastern markets, where it is bought by the tool-steel makers and the electrical-equipment companies.

So the Atolia is a war-baby?

The price of tungsten went up from $7 per unit at the outbreak of the War to $75. The price is now between $15 and $18 per unit and we anticipate a still further reduction when peace is declared.

Do you expect to operate profitably when peace is declared?

We do, because we believe that we can operate the Atolia mine and produce tungsten as cheaply as any other mine in the world. If the price goes to $10, we shall be able to make a fair profit, and we have every reason to believe that it will not go below $10, because a great many new uses have been found for tungsten during the period of the War, and the known sources of supply are limited.

From what episode in your career do you derive the most satisfaction?

There are several episodes that I believe gave me equal satisfaction. Developing the bonanza orebodies in the Independence and Portland mines, the pulling of the Le Roi company out of debt and putting it on a sound financial basis, the opening up and developing of the tremendously rich ore deposits of the Goldfield Consolidated group of mines, together with the building and putting into successful operation of the Goldfield Consolidated mill within a period of eleven months gave me a great deal of pleasure and satisfaction.

Do you consider mining a good career for the young American of today?

I believe there is a good field for trained underground superintendents or foremen. Trained men are difficult to find and are always in demand. In order to fit himself to be an underground foreman, a young man must spend several years as a miner, timber-man, and shift-boss, and if he has the physique together with the courage and patience to gain the necessary experience, I think his services will always be in demand at a good salary.

Do you believe in the adoption of concentration in lieu of amalgamation and cyanidation in the treatment of the low-grade ore at Juneau?

After several months experimenting with a 50-stamp mill at Juneau, with and without amalgamation, we demonstrated that the tailing-loss was no greater using concentration alone than when using amalgamating

plates prior to concentration, while the cost was slightly less. The average ore in the Juneau gold belt is too low in value to bear the expense of cyanidation.

What methods of mining do you consider best for wide bodies of ore separated by considerable thickness of poor ground?

No fixed method can apply to all, as so much depends on the nature and value of the ore deposit and whether the walls, or boundaries, will stand, or are soft and likely to cave. As a rule the poor bands can be left in place or used for filling. Where ore is of good grade, square sets and filling will give the largest percentage of ore-recovery and the best control of stoping. Where an orebody is large and lean, the loss of ore is not so vital and some system of caving or shrinkage may be the most economical.

What are your views concerning the proposed changes in the mining law? I refer more particularly to the abolition of the extra-lateral right and the requirement of discovery before location?

Our present mining laws have been the cause of expensive litigation in the past and appear to me to be more beneficial to the legal profession than to the owners of mines. Senator Smoot's bill withdrawing the extra-lateral right from future locations is a step in the right direction, but locations already made under the extra-lateral law should be left undisturbed as most of them have already settled their differences in Court. In British Columbia claims are staked 1500 ft. square with no extra-lateral rights and the boundary monuments placed by competent men appointed by the Government. Rossland furnished a good example of the operation of both the extra-lateral law and the square location without that right. The first locations made in this district had extra-lateral rights which were the cause of expensive litigation, and expert lawyers and geologists from the United States were imported to try some of the cases. The law was repealed and locations made without extra-lateral rights, the result being that there has been no serious or costly mining litigation over the later locations.

How about the requirement of discovery?

The question of making a discovery before location has many sides to it. Where outcrops carrying ore exist, the law works no hardship on a prospector, but the porphyry copper districts would have experienced many difficulties if discovery before locations had been strictly enforced. At Ely, Nevada, the operating companies purchased from the original locators many claims that had been held for several years without any real discovery. Some of these claims I feel sure never have had an exposure of ore on the surface, but today all are patented. Where no actual outcrop exists and the geological features indicate the possibility of valuable orebodies underneath, the prospector or mining company should be given a prior right to prospect without a discovery and be allowed ample time to sink shafts and demonstrate the value of the territory located.

What do you think of Albert Burch's suggestion to give instruction in mining to American young men at the mines and at the instance of the operating companies?

I fully approve of Mr. Burch's suggested plan of giving free instruction in mining to worthy young men at the expense of large operating companies. Like Mr. Burch, I have seen the young Americans and the strong sturdy men from Cornwall, Ireland, Scotland, Nova Scotia, and Canada gradually disappear from our Western mining camps. I think it is safe to say that in the year 1878 fully 95% of the miners in Nevada came from these countries, and a more intelligent and capable lot of men could not be found anywhere. Many of these men were competent to fill the positions of timber-men, shift-bosses, or foremen. Today the young Americans do not care to spend several years at hard work underground competing with foreigners, many of whom cannot speak English, but I believe that if the companies engaged in mining would furnish schools and teachers that would educate and fit the beginners for the better-paying positions and, when deserving, give the men so trained a preference, it would induce the young men to stick to their jobs and thereby gain the necessary experience to fit them for the positions they knew would be within their reach, provided they proved worthy.

SCHEELITE. The occurrence of tungsten ore in the Coeur d'Alene region, so far as known, is wholly confined to slate. The ore (scheelite) is found in quartz veins associated with gold, silver, pyrite, chalcopyrite, sphalerite, galena, magnetite, and siderite. The vein material varies from white quartz carrying gold, with but little sulphide mineral, to practically solid sulphide, usually rich in gold, with a small amount of quartz, or none at all. The gold is frequently found in pockets, from little bunches to some worth several thousand dollars. Small shoots of ore not infrequently run over $500 per ton in gold and there are large veins that carry from $1 to $7 per ton in gold. Scheelite is found in many places in the region, but only in the slate and argillite. It occurs in bunches, lenses, stringers, and in disseminated grains, and it is known to persist as deep as the deepest workings, 900 ft. below the surface. For the most part the tungsten is found in veins that intersect the slaty rocks in strike and dip and in planes nearly normal to the fissure-veins of the district. In many instances they are traceable for a long distance. These tungsten-bearing veins are found separated by a distance of 200 ft. or less, though the distance is by no means regular. Little mining has been done in the slate area of the Coeur d'Alene in recent years, though it was the field of the first mining activity, in 1883 and 1884.

SULPHURIC ACID to the amount of 100 tons is being made daily at the Garfield smelter from the fume. This formerly went to waste through the stack.

NATURAL GAS to the extent of 628,578,842,000 cu. ft. was used in the industries in the United States in 1915.

Notes on the Metallurgy of Copper

By David H. Browne

*Some of the best ideas of today are really old ideas adapted to modern conditions. Take the charging of blast-furnaces for example. If you analyze the situation there is a lot of food for thought in the subject. A blast-furnace runs continuously, discharging an uninterrupted stream of matte and slag at the spout. Follow what goes on inside the blast-furnace and we find the continuity still existent. Here is a cold charge, continuously descending under the force of gravity, continuously pushing an unfused mass downward into a smelting zone in which it melts into matte and slag. Climb on up the blast-furnace a bit. Is this cold mass continuously replenished? Not so that you could notice it. The charge comes in intermittently. The top of the charge is black just after the charge-cars have been dumped. Watch this charge as it sinks and you notice that as it goes down it gets hotter and hotter, at times and in places coming to a red heat before the next charge follows. This spells heat-losses, more fuel than is needed, and higher smelting costs. Theoretically, charging should be as continuous as the slag-flow, and an even temperature should be maintained at the furnace-top. We have attained this condition in modern reverberatories and by continuous charging of ore and fuel the humps and hollows in the temperature-chart have been ironed out into an unbroken line, which means economical use of the available heat. It would be highly desirable if the same condition could be reached or even approximated in our blast-furnaces.

But we have to consider not only the time when a charge enters the blast-furnaces, but the way in which it is spread. The charge is not uniform. We have ore, both coarse and fine; coke, usually coarse; and flux which may be of any size. Each of these is required at a certain position, and it is this location of the particles that forms the puzzle of blast-furnace charging. In the first place we must provide a way in which the products of combustion can escape readily and under an even pressure. For this reason any stratification of the charge must be vertical and not horizontal. The descending stalactite of unfused charge must have a uniform cross-section at various heights. Hence any arrangement that produces layers—a layer of fine and a layer of coarse ore, for example—is barred by the nature of the case; while any arrangement that tends to build up the various ingredients in vertical column, say, the coarse ore at the centre and the fine ore at the sides, is permissible. Coke—where is it to go? Consider that coke has only one function in the metallurgy of the copper blast-furnace; that is to furnish heat. There is no reduction to be accomplished as in lead and iron smelting. The only consideration is where this heat is best applied. This naturally is along the jacket-walls, to prevent scabs and crusts of unsmelted charge narrowing in the furnace. Coke is only a heat-producer. Some of these days cupolas will be run by powdered coal. In fact, it has been done, the day before yesterday. "Where? How? By whom?" you ask. Wild horses could not drag it from me. Wait a while and you will know all about it. But to get back to the charge-floor. Flux is the next thing. Evidently the flux should go where it is needed—a particle of flux alongside of each particle of ore that needs flux. Hence bedding or thorough mixing of ore and flux outside the furnace is the only common-sense solution of the flux question. So we have the problem to get the ore and flux mixed, to get the coarse ore with its coarse flux along the middle, fine ore and its flux along the outside, and coke as a pad between the fine ore and the furnace-jacket. Add to this the desirability of doing it all continuously and you have the idea.

There was only one charging-machine ever built along these logical lines and that was designed ten years ago by W. H. Freeland, who had more real metallurgical sense than any man I know. This is all ancient history now, but you will find that Freeland's ideas are still alive and every now and then someone makes use of them. The furnaces at Isabella were of the open-top variety; that is to say, the gases were carried to the stack by a lateral take-off below the charging-floor. Freeland had experienced the usual troubles of hand-feeding and to correct these devised his charging-apron, which is generally acknowledged to be the neatest charging-device known to the profession. This machine is rather difficult to describe, but as cuts cost money and the C. M. I. has none to spare, we must see what can be done with the English language.

You know the old fashioned roller-towel that hung behind the kitchen-door. Imagine one of these as wide as the furnace top and as long on the double as the length of the furnace. It is made of steel slats, which are carried on rollers that support it every few feet. These rollers are carried on a horizontal steel frame provided with wheels and running on a track over the furnace. These slats are turned up at the outer edge, so that the whole arrangement forms a sort of pan, with sides formed of these overlapping turned-up edges. Over this belt are two motors. One of these motors propels the machine along the rails, the other turns the rollers and thus makes the belt move. This apparatus stands under the charge-bins, which are very close to the furnace. It passes first under a double row of coke-bins. These pour a double line of coke along this belt at its outer edges, leaving the centre of the belt bare. Passing now under

*From the Bulletin of the Canadian Mining Institute.

the flux-bins a layer of flux is spread along the centre of the belt; over this in turn the ore-bins spread the ore. The machine carrying its charge moves forward toward the furnace. The top of the furnace is covered by a water-cooled lid, resting on wheels, on the track on which the charge-car approaches. The charge-car has a bumper in front. This bumper meets the movable furnace-cover and pushes it along ahead of the charge-car, leaving a slot the width of the furnace through which the charge-feeder can look down into this furnace. If the top of the furnace is level and even, the feeder starts the belt moving, spilling the charge off the end of the belt. The coke falls against the walls because it is piled on the edge of the belt. The mixed ore and flux falls in the middle of the furnace because it was spread down the centre line of the belt. Thus by the time the charge-car has got to the far end of the furnace it has spilled the charge evenly all the way. Reversing the motor the charge-car slides back, pulling the lid over the furnace as it recedes. This is certainly neat in conception and smooth in operation. If the furnace is not working regularly, more or less of the charge can be placed at any spot desired.†

All this, I said, is ancient history. I cite it just to show the persistence of ideas.

At the Granby smelter the charge-cars were hopper-bottom with side-discharge. Three of these cars formed a train the length of the furnace. At the top of each car, axles supported a supplementary set of four wheels. These cars were run directly into the end-doors of the furnace where the upper wheels traveled on rails fastened on the inner side of the walls. When in place the contents were discharged from outside by an operating handle which released the side-gates. Here we have the same idea that Freeland had, of dropping a charge without altering its previous arrangement and adapting this to furnaces that rise above the charge-floor. As a rule, however, almost all the copper-furnaces have been fed from the outside by cars that roll or dump or slide the charge in and thus upset any arrangement. Whether this is simply conservatism or whether it is a necessity imposed by other conditions is a moot question.

The latest development is the device in use at the Calumet & Arizona plant at Douglas.‡ The furnaces are 40 ft. long by 4 ft. wide at the tuyeres. The charge-cars run at right angles to the furnace instead of parallel to it, as is customary. The ore-bins are in the furnace-building parallel to the furnace and fed by overhead belt-conveyors, thus making a very short haul for the cars. In fact, the coke-bins are only 7 ft. and the ore-bins 15 ft. from the furnace-door. The charge-cars are 20 ft. long, and four cars, two on each side, shuttle back and forth between bins and furnace. The charge-car has four compartments and the bins overhead have a gate corresponding to each compartment, so that the amount of charge for any part of the furnace can be regulated. The cars have a sloping bottom that is continued downward into an apron, which, in turn, when moved up to the furnace, is in line with the feeding-aprons above the water-jacket.

This again is neat, particularly the way in which the time element has been taken care of and the haul shortened. It does not, however, take into consideration, as did Freeland's scheme, the accurate placing of coke along the walls and of ore in the centre. Ore, particularly coarse ore, will shoot ahead of the rest of the charge, and fall near the centre if the charge in the furnace is high, or near the opposite wall if it is low, while fine ore will fall more closely off the edge of the apron. It may be that the designers of the Calumet & Arizona furnace had this in mind and make use thereof in the placing of the charge.

When all is said and done, however, Freeland's scheme is the only one which takes into consideration three things, and which does these three accurately. It has the short haul. It places the coke outside next the jackets. It feeds as much or as little as any particular part of the furnace desires. The disadvantage, of course, is that it is adapted only to furnaces that have an unobstructed charging-floor, and that is why it has not been generally adopted. What we really need is some device that will reduce the haul to zero, and that will feed the furnace continuously with a charge in which the ore and flux properly mixed are placed in the centre while the coke is fed mainly against the jackets.

†See Renwick, Mining and Scientific Press, March 22, 1913.

‡McGregor, 'New Copper Smelting Plants,' in Arizona Bulletin, A. I. M. E., August, 1916.

The Minshall gas well, in the Macksburg field of Ohio, was allowed to discharge its gas into the air for ten years. In 1885, when placed partly under control, it had a measured volume of 4,500,000 cu. ft. of gas daily, under a pressure of 425 pounds. It is estimated that the total waste of gas from this single well was not less than 15,000,000,000 cubic feet, equal to 750,000 tons of good coal. A gas well in Kentucky wasted in like manner $3,000,000 worth of fuel. A well in Buena Vista field, Kern county, California, wasted 55,000,000 cu. ft. of gas daily for three months, when it was placed under control. The waste from this one well alone, figured at 25 cents per 1000 cu. ft., was $1,250,000. In the Cushing field of Oklahoma, the waste of gas was larger, perhaps, than in any other field, and at times exceeded 500,000,000 cu. ft. daily. No fires nor open lights were permitted and automobiles were not allowed among the wells for fear of ignition of the gas which filled the atmosphere. The total waste from that field was estimated at 250,000,000,000 cu. ft., equal in fuel value to 12,500,000 tons of coal.

Vessels passing through the Panama Canal require about 11 hr. 40 min., as determined by the average time taken by 158 ships passing through the Canal in October. The greatest length of time for any vessel was a little over 16 hours, but some passed through in less than 8 hours.

Gold output of the Rand in October was valued at $16,370,000.

Geological Occurrence of Manganese

By J. J. Runner

*Of the elements composing the earth's crust, manganese is estimated to form about 0.08%. It is commonly associated with iron which is about 55 times as abundant. Like iron its chief original source is in the basic igneous rocks where it occurs chiefly in silicates, while iron is found in oxides and sulphides as well as in silicates. Since the sulphides of iron particularly favor the basic-igneous rocks, the acid-igneous rocks have a relatively higher manganese-content. Of less importance may be mentioned the association of barium with manganese in many ores.

Of minerals containing manganese, over 110 distinct species have been recognized and described, relatively few of which are important as ores. The ore-minerals are chiefly of secondary origin, derived from the primary silicates after chemical disintegration, solution, and precipitation mostly in the form of oxides. Among the more important ore minerals are the following: psilomelane, MnO_2 with MnO, BaO, or K_2O; pyrolusite, MnO_2; manganite, $Mn_2O_3.H_2O$; braunite, $3Mn_2O_3.MnSiO_3$; hausmannite, Mn_3O_4; wad, an impure mixture of manganese oxides; rhodochrosite, $MnCO_3$; and rhodonite, $MnSiO_3$.

On a commercial basis, ores important because of their manganese-content have been classified in the United States as (1) manganese ores; (2) manganiferous-iron ores; (3) manganiferous-silver ores; (4) manganiferous-zinc ores. The first of these is mined alone for its manganese-content. The second class may be mined for iron alone, or if the manganese-content is high enough, may be used in the production of spiegeleisen, or ferro-manganese. The iron is commonly in the form of limonite or hematite, while the manganese occurs chiefly as psilomelane or pyrolusite. The third class usually contains iron minerals associated with the manganese, and some lead with the silver. They are valuable as (1) sources of lead and silver, the iron and manganese acting as fluxes in smelting; (2) sources of manganese or iron; (3) fluxes in smelting of other lead or silver ores.

From a geological standpoint it is better to classify ores according to their mode of origin, and they shall be discussed here upon that basis. The important deposits of manganese of the world may be classified as (1) residual products of rock weathering and decay; (2) bedded deposits as a result of chemical precipitation in surface waters; (3) lodes; (4) metasomatic deposits; (5) contact deposits. By far the greater part of the world's manganese production is derived from the types illustrated by No. 1 and 2.

Rocks containing manganese minerals in quantities too small to make them of commercial value, may, by processes of weathering and the attendant solution and removal of soluble materials, leave residuals of insoluble manganese compounds with oxides of iron, silica, and clay, that form valuable orebodies. In such ores manganese is commonly accompanied by barium. To this group probably belong most of the manganese deposits of India. They have been responsible for the development of a flourishing industry and have produced several million tons of ore, in some years leading the world in production. One type consists of ores that have been derived from rocks containing manganese-bearing silicates, by decomposition and replacement forming large masses of psilomelane, pyrolusite and braunite. In part the ores are of rhodonite and manganese garnet in crystalline schists. The ore-beds are in places 100 ft. thick, and several have been followed for two miles along the strike. Much of the ore contains 50 to 55% manganese. Manganese-bearing residual clays furnish a source of a small part of the ores of India.

In Brazil valuable manganese deposits occur chiefly in two districts in southern Minas Geraes. In the Miguel-Burnier district manganese ores occur in an ancient sedimentary rock, the same that contains the great Brazilian iron-ore deposits. They are probably to be regarded as syngenetic deposits, in the same sense as the iron ores. Of greater importance as a producer is the Queluz district. The ores occur as surface alterations of a rock containing rhodonite, manganese garnet, manganese olivine, and rhodochrosite. The original garnet-containing rock is considered by some to be an igneous rock, while others look upon it as a product of contact metamorphism, of lenses of manganese carbonate in the schist. The region is one of granite, gneiss, and schist.

In the Huelva district of south-western Spain, occur manganese ores interbedded with a clay slate, and associated with effusive diabase. The ore-lenses consist of banded, compact, or of irregular, coarse carbonate and silicate-manganese minerals, with jasper and hornstone. The lenses are generally less than 500 ft. long, and have an average depth of about 100 ft., and in thickness range from a few feet up to 150 ft. or more. The primary minerals are largely rhodochrosite and rhodonite which in the upper parts have been altered to oxides, chiefly psilomelane. The early production was from the oxidized ores, but later the primary ores began to be mined and in some years, 1877 to 1900, the output ran over 100,000 tons of the latter. The precise mode of origin of the primary ores is in doubt, some regarding them as products of sedimentation, others as a result of metamorphism and cavity filling. The altered surface ores at least are a product of residual weathering. The pro-

*Abstract from 'Manganese Number' of the *Pahasapa Quarterly*, South Dakota School of Mines, Rapid City, S. D.

duction from this district has been large but now has ceased nearly altogether.

In Bosnia, occurs a deposit of hard manganese ore-nodules, lenses and beds of psilomelane, rich in barite, occurring in silicious radiolarite. The original deposit is looked upon as analogous to the concentration of manganese nodules at present forming in the deep sea clays of the ocean.

In southern Bukowina, manganese occurs in the form of pyrolusite, wad, and botryoidal psilomelane, as a weathered product of manganese silicates and carbonate. Ores of this type are also found in Carniola and Moravia. Altogether these districts have produced many thousand tons of ore.

Valuable deposits of manganese have been mined in Cuba on the north flanks of the Sierra Maestra. The ores occur in a disintegrated green glauconitic sandstone. Above this sandstone layer is a bed of foraminiferal limestone. It is probable that the manganese has been concentrated from beds of marine origin.

Most of the manganese ore produced in the United States has been from Virginia, Georgia, Arkansas and California. The Virginian deposits are found chiefly in the James River area, in the Piedmont region, and the Appalachian Valley region. The chief producing region in Georgia has been the Cartersville area in the Appalachian mountains. In both States the manganese occurs chiefly as nodules, grains or lumps, irregularly scattered through residual clay, and in cavities in the underlying rock. The manganese is believed to have been leached from pre-Cambrian crystalline rocks, deposited in Paleozoic sediments, then concentrated by the process of rock weathering and decay. In Arkansas manganese ore is found associated with limestone, in residual pockets, in clay derived by leaching. The Californian deposits are the result of secondary concentration of manganese from a bed of jasper.

Some of the iron ores of the Lake Superior district have furnished important sources of manganese. Little manganese has been mined separately, but some of the ores of iron are rich enough in manganese to be valuable as sources of manganese pig-iron which has special uses. Since these ores have been concentrated largely as a result of leaching by ground waters, they may properly be mentioned here.

The Leadville, Colorado, deposits, famous for their silver, lead and zinc, are generally regarded as replacement deposits in limestone. The primary ores contain about 1% manganese with some iron which in the oxidized zone gives rise to ores containing 15 to 25% manganese oxide and 20 to 30% iron oxide. These surface ores are of three grades, (1) valuable for lead and silver, the manganese and iron acting as fluxes in smelting; (2) as sources of manganese and iron for spiegeleisen; (3) fluxes in the smelting of other ores, the lead and silver being recovered. Similar ores are produced at Neihart and Castle, Montana.

Among the more important deposits of manganese that seem to have been formed as precipitates in surface waters are the following described occurrences:

In the province of Kutais, Trans-Caucasia, occurs one of the world's greatest deposits of manganese. The manganese-bearing bed lies at the base of Lower Eocene sandstone near the surface of a plateau. The deposit is on the average about 7 ft. in thickness, within which are 5 to 12 manganiferous layers of varying thickness, alternating with beds of marl, some of which are also impregnated with ore. The ore consists of oolitic pyrolusite in a matrix or fine-grained, earthy manganese ore. The deposits are said to extend over an area of some 22 square miles. They contain from 40 to 50% manganese. The production from the area has been large, totaling 600,000 tons in some years.

The deposits near Nikopol, south Russia, are similar to those of the Kutais district. The ores are in beds of sandy clay 3½ ft. thick with nodules of pyrolusite and psilomelane, having a concentric or cellular structure. The ores lie only a few feet above crystalline rock from which they are believed to have been derived.

To this class probably belong the deposits of the Coquimbo, and Carrizal districts in Chile, which up to 1900 had furnished several hundred thousand tons of ore, but have produced little since. The deposits form fairly extensive beds in Jurassic-Cretaceous sandstones, slates, limestones and gypsum beds, resting upon igneous rock. The ores are chiefly oxides and silicates with barite, calcite and quartz. The manganese-content averaged 50%.

Of geological interest, but of small economic importance, are the occurrences of manganese that have formed in open fissures or other cavities in rocks. The distribution of payable manganese lodes is limited to a few districts in Germany, France, and Japan.

Closely allied to the manganese lodes are the metasomatic manganese deposits, and like the lodes they are relatively of small economic importance. A number of the iron-manganese deposits of this type are of considerable local importance, such as those at Lindener Mark, Germany.

Of manganese deposits of the contact type those of Langban, Sweden, are best known. The ores occur in dolomite and contain large flat lenses of hematite, and lenticular and clump-like masses of hausmannite and braunite. A large part of them are iron ores, a part iron-manganese ores, and a much smaller portion manganese ores. The ores are particularly interesting for the great variety of minerals found with them.

At Franklin Furnace, New Jersey, occurs a valuable ore of zinc and manganese in pre-Cambrian crystallic limestone in contact with gneiss of igneous origin. The ore is in a layer 12 to 100 ft. thick of metamorphosed limestone occupying a pitching synclinal trough. The ore-mineral of manganese is chiefly franklinite, and is used principally in the production of spiegeleisen after the removal of the zinc by roasting.

MANGANESE mines of Cuba are producing over 5000 tons monthly, the ore running from 43 to 46% manganese. More extensive operations are said to be retarded by shortage of labor.

Geology of the Cedar Range

By G. R. Stevens

The Cedar range lies about half in Mineral county and half in Nye county, Nevada. It has an east-west direction with a length of 14 miles and a maximum width of six miles. It is typical of this arid region, rising abruptly out of the plains.

The topographical features are a rugged core with a maximum elevation of 8000 ft., rolling foot-hills scarred by an occasional bold fault-scarp, and flat valleys. The oldest formation exposed is limestone of early Paleozoic age, but as far as I know no characteristic fossils have been found. It lies non-conformably beneath limestone of the middle Mesozoic. The few fossils I found in this indicated Jurassic age. Both of these limestones have been domed and intruded by grano-diorite and the whole again intruded by dikes of andesite and rhyolite, the flanks being covered by thick flows of lava during Tertiary times. These flows were in turn raised and broken, both by faults and by dikes of biotite-andesite, and tilted along an east-west axis. These last intrusions form the backbone of the range east and west of the older basement rocks exposed in the central core.

Four flows are shown—the oldest a thick andesite. This, wherever observed, is a blue, close-grained, highly-silicified rock. The next is a thick flow of rhyolite breccia showing inclusions, much kaolinized and probably fragments of the older andesite. The abundant large phenocrysts of quartz are the most noticeable feature of this rhyolite. Overlying, and separated from this formation by a stratum of tuff, is a flow, not more than 100 ft. thick, of soft green chloritic andesite. The last member of the series is a close-grained rhyolite weathering with a greenish stain and having much the appearance of the underlying andesite near contact with it. This contact has a thin layer of tuff in it also.

These flows must have followed closely upon each other, as I did not observe any signs of erosion or deposits of laterite where I examined the contacts on the surface or in mine-workings. Above the flows, in the valleys and lower hills, are extensive lake-bed deposits of late Tertiary or early Quaternary age, consisting of chemically-precipitated lime, a variety of alkaline salts, beds of tuff, and several strata of conglomerate, these last being composed of fragments of all the rocks found in the range.

In the Tertiary flows faulting has been extensive, the dominant fault being a thrust on the southern edge of the range and parallel to it. This has brought the underlying grano-diorite in juxtaposition with the flows. The uplift here probably was the cause of the subsidence on the opposite side as shown in the series of nearly parallel normal faults on the northern slope. In the fissures formed by this series of faults nearly all of the most promising veins were formed. Some ore, however, is found on the contacts between the flows. I made a study of one that started in a fissure at right angles to the bedding-planes of the flows, and turned off flatly on a nearly horizontal fault-plane, and in the lower workings occupied the contact between an andesite and a rhyolite flow. This contact showed the effect of movement and is undoubtedly the plane of some minor faulting. The veins have been disturbed by post-mineral faulting nearly parallel with the original fissures, and a series of faults at right angles to the original system. Vein formation was contemporaneous with this last faulting, as indicated in places by a little ore (not 'drag,' but deposited) in the fractures connecting the dislocated segments of a vein. Most of the ore is a replacement and enrichment of original calcite veins. In places considerable calcite is left, making lean spots.

The structural details of a large part of the range are obscured by the lake-bed deposits, the strata of which are flat and unbroken for miles, so that much of interest will remain unsolved until future mine workings give the geologist a chance to study them underground.

The Hornsilver Mine

In 1916 the Hornsilver mine, at Frisco, Utah, paid two dividends, aggregating $40,000. The present owners of this famous old mine have now received a total of $5,962,000. Last year the lessees built a large milling plant to treat the dumps. The mine is at present a producer of lead, silver, and zinc. It was discovered many years ago and a large amount of high-grade ore was shipped. The orebody gave evidence of pinching out and it was sold at a good price to R. C. Chambers, of Salt Lake, who began a vigorous campaign of development, and soon had discovered a second orebody below the first and later found a third. In 1811 the mine produced 8171 tons of base bullion, and in 1882 the output was increased to 16,002 tons. The mine produced at that time 47,232 tons of ore at a cost of $4.44 per ton; smelting at Francklyn cost $14.73, and refining at Chicago $9.05. The ore carried 37.8% lead and 34.2 oz. silver per ton, the smelting loss being 9.71% of the lead and 2.10% of the silver. The average of the grade of bullion was about 93 oz. per ton. In 1882 the dividends amounted to $1,200,000, the net receipts for lead being $1,326,664, thus indicating that the silver paid for nearly the entire cost of mining, smelting, administration, and marketing.

In 1884 the mine produced about 15,000 tons of lead, but the orebodies were rapidly being exhausted and on April 1, 1885, the mine was shut-down and the property remained idle for many years.

Several years ago the mine was re-opened, and under the improved modern methods of mining and metallurgy it has again become an important and profitable property.

MICA amounting to 20 tons daily is produced as a by-product in treating 150 to 300 tons of cassiterite and wolfram ores at the Hill City Tungsten Production Co.'s mill in South Dakota.

Copper Producers of North and South America in 1916

The following figures have been collected by the *Boston News Bureau*, and include all the mines that produced over 1,000,000 lb. of copper during the past year. No account is taken of refinery production, only mine or smelter operations being considered. The yields in pounds were:

	1916	1915	Increase
United States			
Ahmeek	24,069,367	21,800,492	2,268,875
Allouez	10,222,378	10,043,459	187,919
Anaconda	312,900,000	235,076,289	77,823,711
Arizona Commercial	4,150,000	3,592,274	557,726
Arizona Copper	47,884,840	30,304,000	17,580,840
Calumet & Arizona	70,000,000	65,268,910	4,731,090
Calumet & Hecla	76,545,031	72,613,320	3,931,711
Centennial	2,360,965	2,347,500	13,465
Chino	75,644,436	64,887,788	10,756,648
Consolidated Arizona	11,000,000	5,762,974	5,237,026
Copper Range	51,000,000	53,000,000	*2,000,000
East Butte	19,000,000	12,542,058	6,457,942
Franklin	3,100,000	1,314,969	1,785,031
Bingham Mines	745,019	1,221,219	*476,200
Hancock	1,000,000	871,124	128,876
Houghton	210,000	156,766	53,234
Inspiration Consolidated	121,747,000	20,445,670	101,301,330
Iron Cap	1,629,897	1,209,767	420,130
Isle Royale	12,364,584	9,342,106	3,022,478
Kennecott	111,536,000	63,000,000	48,536,000
Lake	1,750,000	1,587,071	162,929
La Salle	1,375,182	782,493	592,689
Magma	9,000,000	6,046,459	2,953,541
Mass Consolidated	4,750,000	4,638,452	111,548
Miami Copper	53,531,134	41,832,059	11,699,075
Mohawk	13,641,349	15,882,914	*2,241,565
Nevada Consolidated	90,409,606	62,726,651	27,682,955
North Butte	24,500,000	19,235,285	5,264,715
Old Dominion	32,500,000	25,307,702	7,192,298
Osceola	19,656,920	19,731,472	*74,552
†Phelps-Dodge	170,000,000	140,478,000	29,522,000
Quincy	21,000,000	22,054,813	*1,054,813
Ray Consolidated	77,818,581	60,358,936	17,459,645
Santa Fe	2,000,000	1,747,090	252,910
Shannon	9,723,570	6,017,642	3,705,928
Shattuck-Arizona	18,161,765	11,154,211	7,007,554
South Lake	300,000	61,637	238,363
Superior	3,028,823	3,866,484	*837,661
Tamarack	6,606,620	3,888,150	2,718,470
Tennessee	10,000,000	12,750,418	*2,750,418
U. S. Smelting (Mammoth)	30,000,000	26,923,674	3,076,326
United Verde	60,000,000	45,127,832	14,872,168
United Verde Extension	20,000,000	.....	20,000,000
Utah Consolidated	12,000,000	8,836,091	3,163,909
Utah Copper	196,776,098	148,397,006	48,379,092
Utah Metal & Tunnel	2,500,000	2,873,815	*373,815
Victoria	1,687,720	1,499,695	188,025
Winona	2,175,000	1,722,638	452,362
Wolverine	6,213,045	7,194,015	*980,970
White Pine	4,215,750	2,824,145	1,391,605
Total	1,862,430,680	1,380,347,535	482,083,145
Mexico			
Greene-Cananea	60,921,000	16,635,081	44,285,919
South America			
Braden	44,671,000	35,444,000	9,227,000
Chile	45,114,000	10,922,000	34,192,000
Cerro de Pasco	71,440,000	61,680,000	9,760,000
Total	161,225,000	108,046,000	53,179,000
Canada			
Granby Consolidated	45,484,142	40,670,598	4,813,544
Consolidated Mining & Smelting	4,446,080	5,306,184	*1,860,104
Canadian Copper	28,000,000	20,000,000	8,000,000
Total	77,930,222	65,976,782	11,953,440
Recapitulation			
United States	1,862,430,680	1,380,347,535	482,083,145
Mexico	60,921,000	16,635,081	44,285,919
South America	161,225,000	108,046,000	53,179,000
Canada	77,930,222	65,976,782	11,953,440
Grand total	2,162,506,902	1,571,005,398	591,501,504

*Decrease.

†Copper Queen, Detroit, Burro Mountain, and Moctezuma.

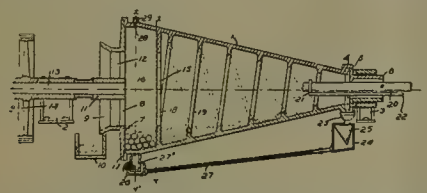
Chemical and Mineral Prices at New York

The following table gives wholesale prices in the second week of January, according to *Metallurgical and Chemical Engineering*:

Chemical and unit	Price	
Acid, acetic, 28%, 100 lb	$3.25	$3.75
Acid, hydrochloric, commercial, 18°, per lb.	0.015	0.0175
Acid, nitric, 36°, per lb	0.0475	0.05
Acid, sulphuric, 60°, per ton	20.00	21.00
Ammonia, 26°, per lb	0.055	0.0575
Barium sulphate, powder, per lb	0.04	0.045
Borax crystals, per lb	0.0775	0.08
Carbon bi-sulphide, per lb	0.055	0.06
Caustic potash, 88-92%, per lb	0.84	0.86
Caustic soda, 76%, per lb	0.0425	0.043
Copper sulphate, 99%, crystals, per lb	0.1225	0.125
Iodine, re-sublimed, per lb	4.00	4.25
Lead acetate, per lb	0.13	0.135
Litharge, domestic, per lb	0.0825	0.09
Manganese dioxide, per lb	0.66	0.70
Potassium carbonate, 80-85%, per lb	0.34	0.36
Potassium cyanide, 98-99%, per lb	2.35	2.50
Potassium nitrate, per lb	0.27	0.30
Potassium permanganate, per lb	2.65	3.00
Silver nitrate, per oz	0.47	.....
Soda ash, 58%, per lb	0.29	0.35
Sodium bicarbonate, domestic, per 100 lb	1.60	1.70
Sodium cyanide, per lb	1.80	1.90
Sodium nitrate, per 100 lb	3.27	3.32
Sodium sulphide, 30% crystals, per lb	0.022	0.023
Strontium nitrate, per lb	0.40	0.50
Sulphur, crude, per ton	35.00	.....
Zinc dust, per lb	0.22	0.26
Cresylic acid, refined No. 5, per lb	0.19	0.22
Pine oil, steam distilled, per gal	0.58	.....
Pine oil, destructively distilled, per gal	0.46	.....
Pine-tar oil, per gal	0.19	.....
Pine tar, thin, per gal	0.18	.....
Turpentine, crude, per gal	0.38	.....
Creosote, coal tar, neutral, per gal	0.155	.....
Creosote, coal tar, acid, per gal	0.215	.....
Coal tar, thin, per gal	0.11	.....
Barytes, white, per ton	25.00	35.00
Feldspar, per ton	8.00	12.00
Talc, American, white, per ton	10.00	13.00
Chrome brick, per ton	120.00	130.00
Magnesite, Grecian, dead burned, per ton	85.00	90.00
Ferro-manganese, per ton	175.00	.....
Ferro-molybdenum, per lb	4.00	.....
Ferro-tungsten, per lb	2.75	.....

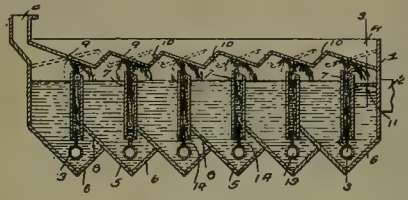
RECENT PATENTS

1,204,231. Amalgamator. Willon Percival Alderson, Timmins, Ontario, Canada. Filed Feb. 19, 1916. Serial No. 79,329.



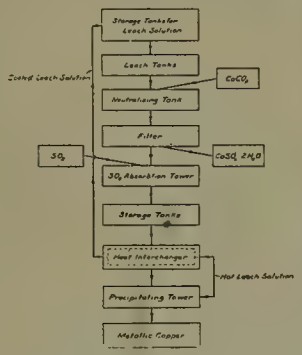
1. An amalgamator comprising a horizontally disposed conical drum rotatably mounted on suitable bearings and having a pulp inlet orifice at one end and a pulp discharge orifice at the opposite end, of means for feeding the mercury into the large end of the drum and carrying it gradually forward toward the small end, and means for discharging the amalgam from the small end of the drum.

1,204,069. Agitator for Ore Treatment. Cyrus Robinson, Mount Vernon, N. Y., assignor to Metallurgical Engineering & Process Corporation, a Corporation of New York. Filed Oct. 1, 1910, Serial No. 584,868. Renewed Mar. 30, 1916. Serial No. 87,850.



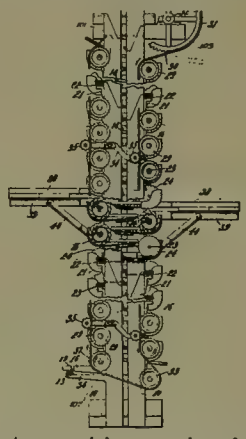
1. In a device of the class described, the combination of a receptacle, a baffle plate, means for projecting separated minute sub-masses of a mixture of ore and solvent solution from the receptacle violently against the said plate, and a second receptacle for receiving the mixture deflected from the said plate, substantially as set forth.

1,201,899. Hydrometallurgy of Copper. Edward Ray Weidlein, Thompson, Nev., assignor to Metals Research Company, New York, N. Y., a Corporation of Maine. Filed Aug. 31, 1915. Serial No. 48,150.



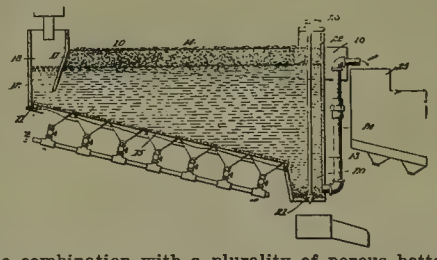
1. The method of precipitating copper from copper sulfate solutions by means of sulfur dioxid, which comprises circulating such solution, together with the sulfur dioxid, in a continuous manner through a precipitating apparatus and heating the same therein to a sufficient temperature and pressure to effect precipitation of the copper and form a residual leach liquor of relatively low percentage in copper as compared with its original copper content, drawing off such leach liquor in a continuous manner, and circulating the same and the ingoing solution in heat interchanging relation with each other, and thereby cooling the hot leach liquor and preheating the ingoing solution; substantially as described.

1,201,386. Cyaniding-Tower. Albert F. Tanner, Greenfield, Wis., assignor to Ideal Continuous Cyaniding Process Company, Davenport, Iowa, a Corporation of Iowa. Filed July 14, 1915. Serial No. 39,735.



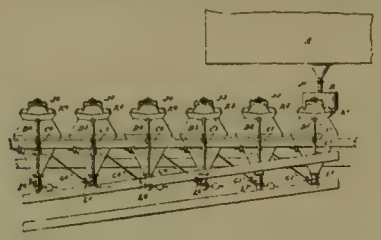
1. A cyanid plant, comprising a series of inclined pans each arranged above the preceding pan in the series with its higher end above the lower end of the said preceding pan, and elevating means adjustably mounted at the lower end of each pan for lifting material therefrom into the upper end of the succeeding pan in the series.

1,201,934. Apparatus for Concentrating Ores. John M. Callow, Salt Lake City, Utah, assignor to Metals Recovery Company, Augusta, Me., a Corporation of Maine. Filed Mar. 4, 1916. Serial No. 82,185.



1. The combination with a plurality of porous bottom, gaseous-bubble separatory tanks, the initial tank having a tailings chamber with a normally slightly open outlet for coarse sands, of a connection between said tanks having one end communicating with said tailings chamber above but proximate to the tailings outlet and having the other end leading into the head end of another tank, said connection having such capacity and discharging in such proximity to the pulp level in the initial tank as to maintain a classifying current in the tailings chamber.

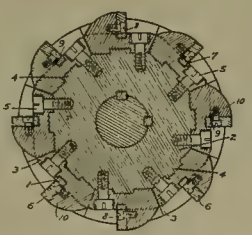
1,203,372. Separation of Metallic Sulfid Ores. Fleury James Lyster, Broken Hill, New South Wales, Australia, assignor, by mesne assignments, to Minerals Separation American Syndicate (1913) Limited, London, England. Filed May 8, 1913. Serial No. 766,346.



1. A process for the separation of lead sulfid from zinc sulfid in ores containing mixed lead and zinc sulfids, which consists in subjecting the said ores to a flotation separation treatment by agitating them with a frothing agent in a non-acid solution of the mineral acid salts of metals which form basic hydroxids, and thereby separating the lead sulfid from the zinc sulfid.

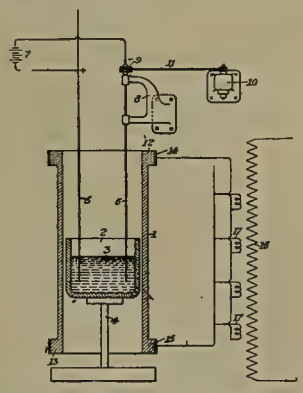
No. 1,203,373, 1,203,374, and 1,203,375, entitled 'Concentration of Ores,' were also granted to the above patentee for flotation improvements.

1,203,901. Crushing-Roll. Ray C. Newhouse, Milwaukee, Wis., assignor to Allis-Chalmers Manufacturing Company, Milwaukee Wis., a Corporation of Delaware. Filed July 18, 1914. Serial No. 852,116.



1. In a crushing roll, a roll core, a plurality of lug plates forming a shell for said core, a plurality of lugs projecting from each of said plates, each of said plates having a longitudinal recess therein adjacent the leading ends of the lugs thereon, and a wearing plate secured to the leading end of each of said lugs and having a portion extending into the adjacent recess.

1,202,534. Production of Metallic Tungsten. Frederick G. Keyes and Robert B. Brownlee, East Orange, N. J., assignors to Cooper Hewitt Electric Company, Hoboken, N. J., a Corporation of New Jersey. Filed July 6, 1914. Serial No. 849,137.



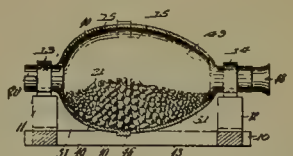
1. The method of producing pure tungsten which consists in bringing an oxid of tungsten to a fluid condition in an inert environment, maintaining the said condition by Joule heat, and separating the tungsten from the electrolyzing bath by an electrolytic process.

2. The method of separating metallic tungsten which consists in subjecting tungsten trioxid to a temperature of approximately 2000 degrees centigrade, thereby producing a lower oxid or mixture of oxids conductive of electricity and also thereby bringing the resultant substance to a fluid condition, maintaining such a condition and passing an electric current therethrough.

3. An electrolytic apparatus comprising a bath of fluid oxid of tungsten, a rotating tungsten cathode and a highly refractory anode.

4. In a fused electrolyzing bath, a cathode of pure tungsten and an anode consisting of a sintered rod of pure tungsten.

1,202,278. Apparatus for Disintegrating Ores and Other Materials. Arthur Feust, New York, N. Y. Filed July 6, 1914. Serial No. 849,200. Renewed Sept. 2, 1916. Serial No. 118,253.

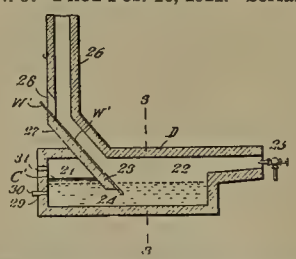


1. In an apparatus for disintegrating ores and other material, the combination of a rotating shell having inlet and outlet openings, formed at its interior to a continuous and unobstructed surface from one opening to the other, the curvature of the shell adjacent one opening being substantially hemispherical and the curvature of the shell adjacent the other opening being substantially paraboloidal or semi-ellipsoidal, and a plurality of differently sized freely movable crushing bodies within the shell co-acting with the said varyingly curved surfaces at the interior of the shell, adjusting themselves according to size, and to the curvature of the interior of the shell.

1,204,843. Process of Extracting Metals From Their Ores. Sidney E. Bretherton and Frank L. Wilson, Berkeley, Cal. Filed Dec. 23, 1912. Serial No. 738,126.

1. The process of removing zinc from zinc sulfid ores, which consists in pulverizing the ore, roasting it to convert the zinc content into basic sulfates, then subjecting the roasted ore to the action under pressure of a solution containing ammonia and carbon dioxid which dissolves the zinc content, then heating the solution to precipitate the zinc as a basic carbonate and removing the precipitate from the solution.

1,204,926. Process for Treating Copper. Frank L. Antisell, Perth Amboy, N. J. Filed Feb. 16, 1911. Serial No. 608,935.



1. The process of refining copper, which consists in melting the copper and then subjecting the molten copper to the action of a purifying agent and then conducting it under a blanket.

2. The process of refining copper, which consists in melting the copper and then subjecting the molten copper to the purifying action of a blanket or cover of a non-metallic salt.

3. The process of refining copper, which consists in melting the copper and conducting the molten copper under a blanket or cover of boron trioxid.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

STATISTICAL REVIEW OF 1916.—SILVER DISCOVERIES.

An output of 455,729 tons of ore, with a gross value of $16,169,558 in 1916, gave the Leadville district a new record, with the possible exception of the total in the early 80's when, it is stated, over $17,000,000 was extracted from the mines of Lake county. It is, however, not known upon what system early-day data was compiled, so there is some doubt about this previous record.

Although the quantity of ore shipped from Leadville mines during 1916 is not as large as that in 1915, the value is an increase of $274,328. The average value of ore marketed in 1915 was $29.80 per ton; last year the average was $35.50, an increase of $5.70. This remarkable advance was mainly due to an increase of 16c. per ounce in the price of silver. The strong silver market that prevailed during the third and fourth quarters of the year caused unusual development in the silver-producing mines, with the result that the silver output for 1916 shows an advance over the previous year of 367,736 oz. The copper output shows an increase of 671,012 lb. over 1915. This metal, 10 cents higher than in 1915, was the other large factor in the increase in the average value. The 2-cent advance in lead was also important, and it is interesting to note that the output last year was greater by 5,238,433 lb. Spelter, on the other hand, registered a drop, the output being lower than in 1915 by 899,182 lb., in spite of the fact that the tonnage of zinc-bearing ore extracted in 1916 was materially greater. The loss in value of the spelter output was $966,493. Gold also showed a decrease, the difference being $603,315. This loss proved to be a surprise, but it must be recalled that during the past year there was a marked falling-off in the extraction of high-grade ore from the gold mines. The Ibex and the St. Louis tunnel, which in 1915 enjoyed a most prosperous year, produced but three small lots of rich ore in the last 12 months. Estimates made early in the year that the 1916 total would be above $18,000,000 proved excessive, but if the zinc-content of the zinc-bearing ores had been maintained to the percentage of the previous year this figure would undoubtedly have been exceeded.

1915 output:	Quantity	Market value	Total value
Gold, ounces	115,121	$20.670	$2,379,551
Silver, ounces	2,733,646	0.498	1,361,356
Lead, pounds	18,534,052	0.046	865,540
Copper, pounds	2,254,268	0.171	387,058
Spelter, pounds	74,208,015	0.130	10,276,725
Manganese, tons	6,250	100.000	625,000
Total value			$15,895,230
1916 output:			
Gold	85,933	$20.670	$1,776,235
Silver	3,101,376	0.656	2,037,015
Lead	23,772,485	0.068	1,624,849
Copper	2,925,280	0.272	796,437
Spelter	73,308,833	0.128	9,310,222
Manganese	11,360	55.000	624,800
Total value			$16,169,558
The gain over 1915 was			$274,328

Aside from the great value of the production in 1916, other works of importance to the future development of the district were commenced during the period. The entrance of several large companies bent on undertaking extensive mining enterprises brought about a change, and it is now apparent that the change is one that was greatly needed. These concerns have grouped together and concentrated into individual projects several large areas of valuable ground that previously were in the hands of numerous small leasing companies, or idle. Development in these tracts in the past has been continued on an essentially inexpensive basis. Mining has been done in a rather slip-shod manner, with little attention being given to anything save economy and tonnage and, as a rule, the economy was costly. Under big company control, an entirely different policy is being carried out. Every preparation has been made to operate on a broad and highly efficient basis. Expensive and powerful modern plants have been installed. The finest electric pumps available have been secured for draining, and underground development has been outlined on a larger scale than has yet been undertaken here. The much needed capital necessary to make big mines at Leadville finally has been obtained, and these mines are now in the making. As progress of the Down Town Mines Co., Empire Zinc Co., U. S. S. R. & E. Co., Iron Silver Mining Co., and Yak Mining, Milling & Tunnel Co. was chronicled in the PRESS during 1916 there is no need to repeat it in this review.

The Prince of Wales Leasing Co., operating the old Bartlett tunnel on Sugar Loaf, has just discovered the richest silver vein that has been opened in the district for years. Where cut, the shoot is 8 ft. wide with 2½ ft. of high-grade silver ore on either wall, and 3½ ft. of talc carrying 41 oz. running through the centre. The entire face averages $200 per ton. The side streaks that show wire and ruby silver throughout will average $1000 per ton. The strike was made by work carried on from the bottom of a 700-ft. winze near the 1700-ft. point in the tunnel. An electric hoist will be installed immediately, and a large quantity of the rich ore extracted.

The old Griffin mine at St. Kevin, reported to be the foundation of the fortune made by the late T. F. Walsh, who operated the property during the early days of the district, is again looming up as one of the richest silver producers in Lake county. A new vein 12 ft. wide, showing a lot of wire silver, has been opened, and preparations are being made to make a large output. The Griffin is 3 miles from the nearest siding, making it necessary to haul the ore that distance by team. New stables are being erected at the siding where 40 horses will be kept. A large boarding-house is under construction at the mine, it being planned to increase the force to 50 men as soon as possible. The property will produce at the rate of 60 tons daily. The Griffin is owned by Lucien W. Smith, manager of the Mt. Champion mine.

OATMAN, ARIZONA

LATEST DEVELOPMENTS BRIEFLY DESCRIBED.

The Gold Road mine has opened a good shoot in the north branch of the main vein 4000 ft. north-east of the old glory-hole. The main vein splits near the Billy Bryan shaft, and work hitherto has been confined to the south branch. Recently a cross-cut was driven to the north branch, a distance of 160 ft. Four feet of ore was cut, then some waste, behind which was seven feet of ore, making a total of 11 ft., which

is of excellent milling grade. Another cross-cut has been started 300 ft. back toward the junction of the two branches. The company is also doing considerable work in the Billy Bryan shaft, which, in the early days of the mine, produced 110 tons of ore that yielded $110,000. The mine was bought four years ago by the United States Smelting, Refining & Mining Co. It has a 300-ton cyanide mill that has been idle since July.

A. C. Werden, manager of the Gold Ore, which lies north-east of the Gold Road mine, announces that the company will soon start construction of a 30 or 50-ton cyanide mill. H. Irving Jones of Denver has been employed to design the mill, and is here to look over the ground. The company sent 2000 tons of $14.50 ore to the Gold Road mill in four months last year. One lot of 26½ tons assayed $480 per ton. A winze from the 530-ft. level was sunk 33 ft. in 5 ft. of ore that averaged $40 per ton.

The Gold Road Bonanza is cross-cutting at a depth of 525 ft. for a 4-ft. vein that dipped through the shaft a few feet below the 500-ft. level. The average of 60 samples taken from this vein was $30 per ton. It is thought to be a branch or spur from the main vein, and will be followed by a drift.

have been hindered by a heavy flow of water, and new station and electrically driven sinking-pumps have been installed. A 900-ft. Sullivan compressor was received last week for use at this shaft.

Shaft-sinking is in progress at the Big Jim mine. The shaft has been sunk 55 ft. from the 485-ft. level. A station will be cut at 600 ft. and a cross-cut driven to the vein, about 90 ft. Of this work, Horace V. Winchell, who examined and sampled the mine in December last, said in his report: "A level at the depth of 600 ft. will in all probability double the value of the estimated ore, and is likely to encounter some of the bonanza shoots for which the district is famous." The company is working on plans for a 400-ton cyanide mill.

JOPLIN, MISSOURI

REVIEW OF THE MISSOURI-KANSAS-OKLAHOMA ZINC-LEAD REGION IN 1916.

Again the Missouri-Kansas-Oklahoma region has made new records in production and value of its zinc and lead products. The year 1916 yielded the greatest quantity on record; namely,

VIEW OF OATMAN DISTRICT, ARIZONA.

On the right is the Aztec shaft of the Tom Reed company; Big Jim shaft behind. On the left, behind knoll, is the Gray Eagle shaft of the Tom Reed; behind this is main shaft and mill. In centre background is Oatman. On knoll in background to right of town is No. 2 shaft and mill of United Eastern.

On the 400-ft. level, the Adams Mining Co. has drilled into the hanging wall of the vein. The holes released much water and will not be shot until a bulkhead is put in. The Adams is in the Black Range section of the district, and has a good surface showing.

There is much discussion of a strike of high-grade ore in the United Eastern mine. The company refuses to divulge information concerning it. Local reports are that a streak of rich ore on the hanging wall has been opened on the 300, 445, 565, and 665-ft. levels, which varies from 4 in. to 6 ft. in width. Some rich specimens have been seen. The new mill is reported to be working satisfactorily treating 200 tons per day. According to official reports made last summer, the average throughout the mine is $25 per ton.

Extensive development continues in the south-east of the Tom Reed. The Aztec shaft is down 460 ft. having cut the vein at 430 ft., and it is expected to get through the vein at 480 ft. The better ore appears to be on the foot-wall side, an average grab sample taken recently assaying $57. Operations

349,690 tons of blende, 28,779 tons of calamine, and 53,326 tons of lead ores. No previous year approached this great quantity, the nearest being 1915 when the output was 56,317 tons less of blende, 8210 tons of calamine, and 7281 tons of lead. The blende concentrate was valued at $29,693,214, which was double the value of previous normal years, and $6,814,819 greater than the previous record output of 1915. The value of calamine totaled $1,773,118, a record for this ore, and $682,597 greater in value than in 1915. The value of lead ore was $4,488,986, more than double the value of previous normal years, and $1,974,673 ahead of the output of 1915. With such figures it is no wonder that the Joplin district last year was a hive of industry and experienced the greatest prosperity it has ever known.

PRICES. While the total value of the ores was more in 1916 than in 1915, one record was not greater; namely, the price of $135 per ton for zinc concentrate (60% metal) during one week in 1915 was not reached in 1916. However, the average price paid for blende, $84.91, for 1916, was $6.93 above the

average of 1915. Taken as a whole therefore, the market prices for zinc ore in 1916 was higher and more steady. In January the price opened strong, showing an average of $99.82 during the month for all grades. February saw a distinct stiffening of the market, which rose to $125 for some lots of high-grade ore, these being the highest prices paid during the year. The average of the month was $108.90 on all grades. The market sagged a little in March, but no slump was noticeable, the average being maintained at $99.10. April saw extremely heavy buying, and under the stimulus of this great demand prices again advanced to the $125 level, and sufficient quantity was sold to show an average of $106.45 for the month. This was one of the best months of the year, 43,747 tons of blende and 4080 tons of calamine being marketed. Then the market began to weaken under the stress of less demand and by August prices had dropped until the average was $56.60. Thenceforward there was a gradual advance for zinc until the first three weeks of December, when the base price again went over the $100 mark. The peace rumors flattened out the zinc market, there being a drop from a maximum of $115 to a minimum of $70. The average for the entire month was $87.26.

The prices of calamine opened as firmly as blende in January, and while the shipment was small, the average for the month was $74.15. The market held uniformly firm until April, when prices leaped upward along with blende, and calamine registered its high mark of $81.62 on an average for the month. The market went down from then on until the end of October, that month registering only $39.68 as an average for the month's shipments. November and December showed improvements in demand, practically one-fourth of the entire year's shipments being made in those two months. Under the stimulus of this demand prices again rose above the $50 mark for monthly averages.

PRODUCTION AND SURPLUS STOCKS. Production was marked off into three periods in 1916. The first four months of the year were the periods of heavy demand and high prices, and while production was fair, the winter conditions were such as to hinder maximum production. The stimulative action of high prices, however, was making itself felt, and the next four months showed the results of this stimulation by the extra activity at the mines and mills that had been put into the production column under the promise of the prices paid the first four months of the year. From an output of 7500 tons per week in January, this rose to 10,000 tons in June and July. At this period prices were growing lower, and the extremely severe drought was having its effect in curtailing production. This heavy production resulted also in raising the surplus stock of 4000 tons in January to 32,250 tons by the end of July. This was the largest quantity of surplus stock that has ever been accumulated in the Joplin district, and was long considered as a serious factor in depressing the local zinc-ore market. Owing to the accumulation of the surplus stocks and the lowered prices, coupled with the drought and the lack of electric power, production again ebbed, and when the heavier demand began to make itself felt in November and the earlier part of December, when the shipments approximated 10,000 tons per week, the surplus began to dwindle, and by the end of the year had reached approximately 1500 tons, the lowest point for the whole of 1916. The tide is gradually rising again and the output is now close to 8000 to 9000 tons per week. Were fuel and power conditions normal, the output would be nearer 10,000 tons.

What has been said of production and surplus stocks of blende applies in the same proportion to lead, the same ebb and flow of production and surplus being noticed, and practically for the same reasons. The year opened with 1435 tons of surplus. By the end of April it was down to 750 tons, after the heavy buying of that month at record price. With the decline in value there was also an increase in the surplus, and by the end of July 2680 tons had been accumulated and reasonably heavy shipments were made also. Thenceforward, the surplus dropped quickly, and at the end of October practically every bin was empty. By the end of December the stock-pile had accumulated to 400 tons.

The following tables gives the blende, calamine, and lead ore shipments, prices, value, and surplus stocks for each month of 1916:

ZINC-BLENDE SHIPMENTS, PRICES, VALUE, AND SURPLUS STOCKS FOR 1916:

Month	Tons	Average prices	Value	Surplus stock at end of month
January	26,126	$99.82	$2,608,002	4,000
February	27,465	108.90	2,991,309	3,000
March	24,924	99.10	2,470,298	10,465
April	43,747	106.45	4,658,014	8,200
May	26,840	90.14	2,419,382	17,190
June	26,077	74.26	1,936,485	23,650
July	26,947	67.72	1,825,050	32,250
August	16,147	59.11	954,477	32,230
September	31,074	56.60	1,758,711	18,820
October	27,679	64.34	1,780,830	10,590
November	28,260	85.41	2,415,729	3,945
December	44,404	87.26	3,874,927	1,500
Total	349,690	$84.91	$29,693,214	1,500

CALAMINE SHIPMENTS, PRICES, AND VALUE FOR 1916:

Month	Tons	Prices	Value
January	1,343	$74.17	$99,617
February	2,860	75.82	216,851
March	2,252	73.61	165,782
April	4,080	81.62	333,041
May	2,487	64.16	159,569
June	2,160	53.57	115,724
July	925	46.26	42,796
August	1,322	40.23	53,192
September	2,907	42.12	122,445
October	1,848	39.68	73,328
November	3,319	50.80	168,630
December	4,276	51.95	222,143
Total	29,779	$59.54	$1,773,118

LEAD ORE SHIPMENTS, PRICES, VALUE AND SURPLUS STOCKS FOR 1916:

Month	Tons	Average prices	Value	Surplus stock at end of month
January	3,781	$75.69	$286,153	1,435
February	4,218	84.00	354,510	1,100
March	5,331	92.37	491,108	635
April	6,333	100.44	635,944	750
May	4,407	95.51	420,920	1,200
June	3,872	81.30	314,745	2,000
July	4,392	73.20	321,802	2,680
August	2,841	65.50	186,122	2,550
September	4,655	67.90	316,406	1,130
October	4,253	78.00	331,769	85
November	3,417	86.41	295,277	370
December	5,826	91.70	534,280	400
Total	53,326	$84.18	$4,488,986	....

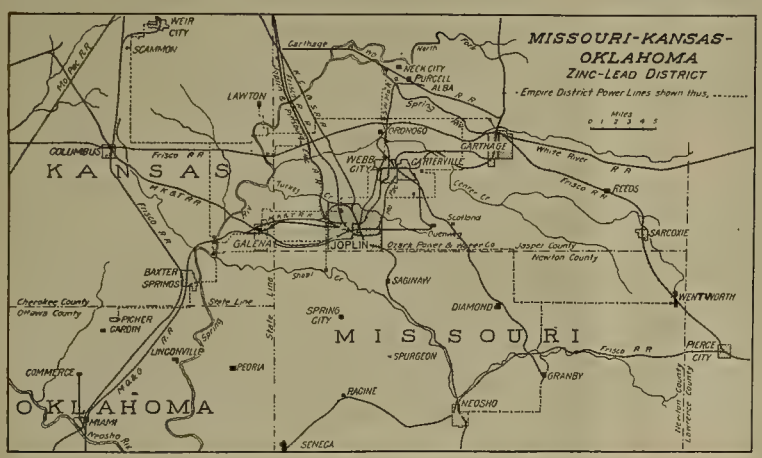
While lead ore was longer in reaching its maximum height, this year's levels were the best ever known here. At least two months (April and December) of the year showed base offerings above $100 for 80% lead-content. The market opened between $70 and $80, and gradually rose to the high record in April when the average for the entire month was $100.44. At these prices shipments were over 6000 tons, the greatest of any month of the year. The market then went down by gradations

until August, when the trend started again in the upward direction. December showed an average for all grades of $91.70.

New Developments. All of the main centres of the region have shown increased production, but to the Oklahoma districts must be handed the banner for the largest increase in output and the most important developments during the past year. While the Oklahoma centres have shown remarkable growth from the moment of their inception, it took the unusual prices of the past two years to bring out their merits and call the attention of mine operators who had become fixed in the older camps of the field. This year, week by week, has noted the gradual increase of the production of the Oklahoma districts up to May. From then on production bounded up until for many weeks they led the entire region, and promise to be the most important producers here for some time to come. From a single area at Commerce the district has now expanded to four others. Besides Commerce, there is Cardin, Century, Picher, and Quapaw. From a little group of mills at Commerce there are now these five main groups, together with many connecting mines between. Nor does the development stop with the State line, the new prospecting and development work has been carried across into Kansas, and now stretches northward to a point north-west of Baxter Springs, Kansas.

Mill Building in the New Field. At no time and in no other district has there ever been such a large number of mills constructed within so short a period of time. Fully 40 mills have been constructed in the Oklahoma section during 1916. the period of mill construction has not ceased. It is now at its height, and the first six months of 1917 will probably be as great a period for mill construction, and may perhaps be greater than the past half-year.

Drill Prospecting. Another peculiar feature of development in this new Oklahoma and Kansas field is the amount and character of the prospect drilling carried on. In this field there have been from 150 to 250 drill-rigs at work throughout the year. One could stand in one spot on the prairie and count from 65 to 100 rigs. In this respect the field resembled more an oil-field than it did the ordinary zinc-field of the older portions of the region. The results of this drilling campaign have been remarkable. Not only have these prospectors opened new ground, but the deposits discovered have been the richest so far found in this region. With so many strikes made of such uniform richness there has naturally been attracted to the field not only a large number of new prospectors, but among them has gone practically every important zinc-producing company in the United States. It is not often that a single district commands the mining resources of an entire industry, but the new Oklahoma and Kansas field has been fortunate in this regard.



Character of the New Discoveries. The earlier discoveries of zinc and lead ores at or near Miami in the old Commerce district were at shallow levels, and the ores contained large amounts of pyrite and bitumen. Both of these ingredients brought down the grade of the ore and seriously interfered with concentration. This place later developed ores at lower levels that were free from these deleterious substances. The new discoveries have been principally around 160 to 220 ft. in depth, and these generally have been free from the bitumen or pyrite. The faces are usually high, and the ore carries from 5 to 25% lead and zinc. The ore concentrates to a 60% blende concentrate or even better, while the lead will concentrate to 80% concentrate or over. Owing to the high value of the ores the capacity of the mills is not as good as the same class of plants in the sheet-ground district. Mining conditions have been rather difficult owing to the large flow of water which always prevails in any new centre, and which in this district has proved not only heavy but of more or less artesian character. For this reason it has taken a great deal of pumping to reduce the pressure, and even then the drainage is within limited areas, making it necessary for any new group of mines or new mine outside of the drained area to fight the heavy water from the start. This has made shaft-sinking expensive, and it has necessitated comparatively slow development. Other difficulties in the way of operating conditions lie in the absence of rock roads and a main-line railroad directly through the district. Practically all developments lie two to four miles from the main line of the Frisco and M. O. & G. lines. A small branch road comes out from Miami through the Commerce, Picher, and Cardin districts now, but this is entirely inadequate for the needs of these places. Much of the heavy machinery has been hauled by motor-trucks and teams, and with bad weather and soft roads this soon brings a condition of practical impassability in some places. Road conditions, however, are being improved rapidly. A fairly good rock road has been completed all the way through from Miami to Joplin, and with the completion of side roads it will not be long until this feature of operations will become normal. The building of bridges over streams at Tar creek and its branches that ramify through the new centres will also improve conditions in that field and will greatly facilitate operations.

Trend of New Developments. Most of the new development in Oklahoma has extended from a point two miles north of Miami in a north-easterly direction. This trend has continued north-east across the State line into Kansas, and a connecting line of drills now runs from a point one mile north and west of Baxter Springs, south-west to Commerce. Along this line there are points where development has been wider than others, but whether the trend is caused purely by the locations of the development or whether the deposits simply lie in this direction remains yet to be proved by more extensive prospecting. There are some indications, however, that there are some cross-trends of ore-channels bearing off from this main developed trend. This seems to be shown by the work running from Cardin south-east through Century to Quapaw, and from Cardin north-west a distance of four miles. It is also apparent from recent discoveries that there is an area south-west of Columbus, Kansas, which may be connected up with the main developments near Picher, through discoveries of ore near Melrose, Kansas. This means an extension of the field westward a distance of 10 to 14 miles, and opens possibilities of new territory of amazing extent. Acting on the working hypothesis that the main trend of ore so far discovered and running from Commerce to the Baxter field will eventually connect up with the developments around the Badger-Peacock and Lawton dis-

tricts, there have been a number of operators taking up leases along this line, who have even extended their operations northeast of Badger-Peacock and Lawton as far as Waco, Kansas, and Asbury, Missouri.

Whether this theory be true or not there have been some excellent strikes made near Waco, Kansas. These have been of the same character as those west and south-west of Baxter Springs, and in Oklahoma. Drills penetrate the usual thickness of Pennsylvanian shales and sandstones, then pass into Mississippian limestones and chert and catch the ore deposits at 160 to 220 ft. It would appear from the way leases are now being taken, and the way drill prospecting is being located, that the major portion of the next year's new development will lie in the territory stretching from Waco, Kansas, south-west past Baxter Springs. This will add a long strip of country to the western portion of the district, and will greatly increase the importance of Kansas as a zinc-producing State.

Missouri Developments. Owing to the unusual excitement regarding the Oklahoma and Kansas discoveries there has not been the usual attention given to new developments on the Missouri side of the zinc district. This does not mean that there have been no new developments, but that their number is small compared to those already mentioned. Results in Missouri have been more in the way of ordinary extension within the limits of the old centres. At Duenweg there have been important additions to ore reserves through the drill prospecting carried on by Molloy and Cameron on the Hall land. Here some of the best sheet-ground discovered for years has been tested and proved. Throughout Duenweg there has been stimulated by this discovery renewed activity which has resulted in building of several mills, and the addition of considerable tonnage to the weekly output.

Joplin men—L. C. Church and J. H. Wright—are heading the Tri-State Mining Co., recently formed with a capital of $500,000 to operate from Century and Picher to Baxter Springs, Kansas. Drilling is to cost $100,000 on the 2000 acres held. The Butte & Superior company is drilling in adjoining ground.

In a building 90 by 110 ft. the Oronogo Mutual Mining Co. is to install an Allis-Chalmers engine, General Electric 1200-kw. generator, and 2600-cu. ft. air-compressor, costing in all $70,000. Two water-tube boilers of 400 and 350-hp. will supply steam.

The old Aurora district has been the scene of considerable prospecting and development. Among the new mines brought out by the prospecting which have shown remarkable records was the Red Wasp. This property has developed into one of the richest producers of the entire region. Other properties which have been revived have been the United Zinc Co. tracts and their sub-lessees. Still farther east at Springfield there have been a number of new properties opened at the junction of Pierson creek with the James river. There has also been a revival of mining operations at Ash Grove and Greenfield. The operations have not been of large extent nor importance.

Arkansas Developments. Stimulated by high prices, many attempts have been made to revive operations in various parts of northern Arkansas. Most of the new activities however have been in the Rush district. Here a number of the old properties have been re-opened, and in some cases new deposits discovered and developed. Among the better producers of the year have been the Edith, Red Cloud, Yellow Rose, and Silver Hollow. Practically every little place in north Arkansas has received attention. Properties around Yellville, Harrison, Dodge City, Mountain Home, Ponca City, Jasper, and St. Joe, have been the scene of considerable new prospecting, which has resulted in some discoveries of ore. The production for the year will be materially larger than for many years. The only producer of exceptional merit developed during the year in the Arkansas field was the Edith mine in the Rush district. There was also more or less prospecting in south-western Arkansas near Vandervoort and Gilham and across into Oklahoma, but this has not resulted in any workable deposits of ore so far.

TORONTO, ONTARIO

Gold Mining in 1916.—Porcupine Notes.—Steel Output.

The past year has been characterized by a remarkable expansion of gold mining at Porcupine and the newer gold districts, and increased interest and confidence on the part of investors as to the future. Numerous prospects have been developed to the producing stage or are rapidly approaching it, and there is every likelihood that before the end of 1917 Porcupine will have at least 20 producing mines. Great advances have also been made in the Boston Creek, Kirkland Lake, and Munro Township areas, and large sums of American capital are being attracted.

During December the Dome Mines produced $183,300 from 39,000 tons of ore of the value of $4.70 per ton. The working cost was $2.77 per ton, a reduction of 11c., which is an excellent showing considering the high cost of materials. A rich strike recently made at the 700-ft. level is stated to assay $14 per ton across a wide vein.——The 4-weekly statement of the Hollinger Consolidated for the period ended December 1, shows gross profits of $240,075 from the treatment of 50,304 tons of $8.78 ore. The working cost was $3.74 per ton. The mill ran 90.5% of the possible running time. The construction work now in progress resulted in a deficit of $238,703.——At a meeting held in Toronto on December 28 the shareholders of the McIntyre ratified the arrangements for a merger with the McIntyre Extension and Jupiter companies and authorized an increase in the capital from $3,000,000 to $4,000,000. The company has taken an option for one year on the Plenaurum, adjoining the Jupiter, and agrees to spend $53,000 in its development.——The Schumacher is diamond-drilling in the 300-ft. level to pick up the high-grade vein found on the 100-ft. level south of the main workings. Gold-content of the ore sent to the mill from the upper level is better.——A rich strike is reported on the Gold Reefs property in a narrow vein encountered on the 50-ft. level.——At the Davidson a raise has been made from the 100-ft. level to the surface, and an intermediate level at 50 ft. will be driven to prove the main orebody. On the 300-ft. level the vein is showing satisfactorily and a substantial tonnage of high-grade ore has been exposed.

The power-line to Kirkland Lake is approaching completion and is expected to be in operation about February 1, when active development will be at once undertaken on several properties.——La Belle Kirkland has opened a vein system to a depth of 350 ft., and blocked-out a large orebody, and has gone down 100 ft. on another vein. Diamond-drilling is being undertaken to prove both bodies at depth.——The Minaker claims have been acquired by Rochester capitalists, and surface exploration is being carried on.——The Hunton-Kirkland property, comprising 40 acres, has passed into the control of H. Cecil and associates of New York.

At Boston Creek, the Boston Creek property, comprising over 100 acres, is being developed on an extensive scale with J. R. Rutherford, a graduate of McGill University in charge. About $250,000 has already been spent and the value of ore blocked out is estimated at $1,500,000. The vein has widened from 4 ft. at the surface to 12 ft. on the 200-ft. level, and the gold-content is reported to be high. Power is obtained from the Northern Ontario Power Co.'s line.——The O'Donald group of claims adjoining the Boston Creek, and embracing 190 acres, have been taken over on option by the Crown Reserve of Cobalt. Camp buildings are under construction and surface work has been commenced preparatory to development.

An official statement of the output of the Dominion Steel Corporation of Sydney, Nova Scotia, for 1916 shows that the past year has broken all records owing to the enormous demand for steel for the manufacture of munitions. The production of pig iron was 348,000 tons, being 12½% in excess of the previous year's output, and steel ingots were produced to the amount of 376,000 tons, an increase of 8%.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

The fourth annual report of the Governor of Alaska, J. F. A. Strong, for the fiscal year ended June 30, 1916, is just to hand. With a map of the Territory it covers 109 pages, dealing with the commercial, economic, industrial, and social conditions. The Governor considers that the isolation of Alaska is a great drawback, so far as development and progress are concerned. Until within the past 12 years or less Congress has not given Alaska the fair consideration due. Notwithstanding all the adverse conditions Alaska continues to make substantial progress in developing its resources. The report then discusses mining, water-power, fisheries, forests, furs, etc.

JUNEAU. November returns of the mines on Douglas island show that the Alaska Mexican made a profit of $1104 from 12,075 tons of $1.33 ore, less $5698 for construction. From 25,627 tons the Alaska Treadwell's operating profit was $26,455, less $17,711 for construction. The ore yielded $2.28 per ton. The Alaska United's Ready Bullion and 700 Foot mines made a loss of $60,988 on the treatment of 42,640 tons of $1.82 to $2.29 ore. Construction accounted for $37,973.

PROPERTIES IN THE JUNEAU DISTRICT, ALASKA.

ARIZONA

During the past 18 months the Arizona State Bureau of Mines has issued 50 bulletins on various subjects of interest to the people of the State. It is the aim of the Bureau to have eventually a bulletin that will cover practically every inquiry that comes to the office, although it will be some time, of course, before this is realized. The Bureau has recognized the difficulty of giving, in individual letters, as complete information as is often desired, and considers that a bulletin, even a short one, will prove much more satisfactory. Nearly 100,000 bulletins have been sent from the office during the past year and a half, so the demand for this information is evident. The bulletins are published in series, as follows: mineral technology, economic, law, safety, metallurgical, county resource, mining, labor, and machinery.

MIAMI. At the coarse-crushing plant of the Inspiration Consolidated, No. 4 section has recently been fitted with the necessary equipment for screening-out fine material that it is unnecessary to send to the secondary crusher. Heretofore in this section all the product from the gyratory-crushers was fed to the Symons disc-crusher, the fine material thus occupying uselessly valuable space within the crushing area of the machine. By screening-out the fine and passing it around the Symons crushers, the capacity of these machines will be largely increased, and their operation benefited. When wet, fine material gets into the machines it has a tendency to clog the discharge. This clogging is never apparent when the feed material is dry. It is interesting to note that the Miami Copper Co. is making preparations to install this type of crusher in its coarse-crushing plant to replace the rolls that have been in use since the plant started operations. Another interesting feature in regard to the crushing at the Miami mill lies in the fact that the rolls at the head of one of the mill sections are to be replaced by Hardinge conical ball-mills.

The Miami Copper Co. reports as follows concerning its flotation results in December:

	December	November	October
Feed, tons	121,493	120,988	102,698
Concentrate, tons	1,480	1,589	1,370
Copper in feed, per cent.	1.118	1.157	1.119
Copper in concentrate, per cent.	41.521	41.439	40.987
Copper in tailing, per cent.	0.620	0.621	0.58
Value of concentrate	$278,513	$299,396	.....

Appeal of the Miami from the decision of the United States Court in Delaware in the flotation suit will be heard this month, arguments to be heard January 29 at Philadelphia.

CALIFORNIA

KESWICK. The Mountain Copper Co.'s 250-ton flotation plant is being doubled in capacity. A leaching plant is to be erected. Ore and concentrate are sent to the company's smelter at Martinez on San Francisco bay.

MARYSVILLE. In the suit of the Yuba Investment Co. *v.* the Yuba Consolidated Gold Fields Co. to quiet title to 1639 acres of land at Hammonton, in the Court since last May, Judge E. P. McDaniel decided in favor of the defendant. The land is valued at $350,000 for dredging purposes.

(Special Correspondence.)—A sale that means much to Sierra City has been consummated within the past 10 days. The Recorder's office at Downieville discloses the information that John C. Mansfield, an old resident of Sierra county, has bonded his Shamrock quartz claims to John V. Powers, the Amador attorney, and that the latter has made the initial payment of $5000 on a total price of $100,000. It is understood that a group of capitalists headed by W. C. H. Dibblee, the well-known banker of San Luis Obispo, will take over the property from Mr. Powers, and begin extensive exploration as soon as weather conditions permit. The Shamrock property adjoins the Sierra Buttes mine, which in the past years has sent to the Mint over $16,000,000 in gold, and is within a short distance of some of the State's past best producers. The Shamrock has never been systematically developed, but has what is considered to be one of the best surface showings in Sierra county. The property comprises 14 claims and water-rights sufficient for all power purposes.

Sierra City, January 18.

(Special Correspondence.)—Results of prospecting with a Keystone drill by the Springfield Tunnel & Development Co. have been exceedingly satisfactory so far. This week rich gravel was encountered in what is known as the Fox channel. It is stated that operations will be resumed in the long drainage adit as soon as the depth of the main channels has been determined. It is estimated that another year's work will be required to complete the adit, whose cost will be approximately $100,000.

An option for the purchase of the Rawhide No. 2, adjoining the well-known Rawhide mine, has been given by the Hobart estate to H. H. Stambaugh and R. C. Steese, of Youngstown, Ohio. It is stated that in the closing of the deal a good sum changed hands. Stambaugh and Steese have also purchased the surface rights to 30 acres adjacent on the east from the heirs of the late Matthew Arneld. It is understood that work will commence immediately.

A vein on the F. Cavalero ranch, in the outskirts of Sonora, is being prospected under the direction of C. E. Reeves. The vein, which is supposed to be the same as the Gerrymander, a mine that was worked to a considerable extent a number of years ago, has been exposed in several places by shallow shafts and open-cuts, and the showing has been most gratifying. The sinking of a permanent working shaft is contemplated.

The drift at the 160-ft. level in the Chilano mine, near Tuttletown, has been driven into a body of rich ore, a streak of the vein being liberally speckled with gold. The property, owned by Gillis, Booker and Harkinson, of this county, was recently bonded to F. W. Bernard, of Beverly, Massachusetts, with whom it is understood other men of the East have become associated. Only a few men have been employed, but it is thought the strike just made will induce the bond-holders to undertake operations on a larger scale.

Sonora, January 12.

(Special Correspondence.)—A new pump has been installed at the 1400-ft. level of the Old Eureka shaft, and excellent headway is being made in lowering the water as well as in retimbering the shaft below that point. The new head-frame is almost completed, and will be ready to operate as soon as the electric equipment is complete. Men have been engaged in placing the large hoist on its foundations, and getting everything ready for making connections as soon as the motors can be installed. No attempt will be made to fill in the low ground around the shaft-collar to the level of the engine-room until the hoist is in operation, when the waste from the mine will be used for this purpose.

At the Central Eureka mine sinking for a sump below the proposed 3350-ft. level is in progress. As soon as the necessary room is provided for sump and shaft chutes, a station will be cut and driving started both north and south on the ore developed in the course of sinking, at a point 150 ft. below the present lowest level, 3200 feet.

Contrary to expectations, sinking the Bunker Hill shaft an additional 600 ft. has been delayed owing to the necessity for straightening a bend in the shaft that occurred in previous sinking operations. In the last 100 ft., the shaft veered about 4 ft. to the south. Men are now engaged in adjusting this by cutting into the north wall of the shaft and moving the timbers into line. Some weeks' time may yet be required before this adjustment is completed, after which the proposed new work will be started.

The Argonaut company has almost completed the new mill west of the shaft, 20 heavy new stamps having been installed. As soon as these are ready to drop, 20 at a time will be removed from the old mill to the new and the remaining stamps kept in operation, so no unnecessary time will be lost. When the last battery of the old mill is removed to its new place, the Argonaut will be equipped with a modern 60-stamp mill. M. Latham and J. Simonds of Melones, Calaveras county, have secured an option on the tailing stored below the old mill, and they contemplate treating this by a 150-ton cyanide plant. Over 200,000 tons has been stored in this dam, which, according to recent tests, assay from $1.75 to $2.50 per ton. As these men have successfully treated tailing dumps in Calaveras county, their operations here will be watched with interest. From the new mill, the tailing will flow by gravity to the Eastwood dam erected during the past year.

An electric hoist is being installed at the North Star shaft of the South Keystone property, and it is expected that the actual work of unwatering the shaft will begin about the middle of January. Engine-room, compressor-house, and other mine buildings have been erected.

Suit has been commenced in the Superior Court of this county by the Original Amador Consolidated Co. against James E. Bastian, the company having filed complaint in ejectment, alleging that defendant entered upon the Last Chance Lode claim, part of the Little Amador group, and unlawfully ousted plaintiff from a portion of said premises. The mining company demands not only possession of the disputed ground, but $5000 damages and costs of suit. A similar suit for $5000 damages is pending against Frank Gallardo on complaint filed by the same company.

Rumors are afloat to the effect that a strong syndicate is about to bond the South Jackson and the Moore mine near Jackson. The last company operating the South Jackson had to abandon its work for lack of capital, at a time when prospects of the early development of pay ore seemed excellent. A three-compartment vertical shaft was sunk to a depth of 577 ft., and levels opened at 210, 345, and 500 ft., from each of which considerable prospecting was done, with the result that three veins were developed, the west, middle, and Zeila. The mine is equipped with electric hoist, compressor, motors, and a 50-ft. head-frame. Maurice and Jeffrey Schweitzer of San Francisco, J. E. Davis of Melones, and F. W. Ruhser, Adam Huberty, and C. P. Vicini of Jackson, are heavily interested in the South Jackson property, while the Moore mine is owned by the Patterson estate of Fresno. The latter has been idle for many years and the workings are caved, but it is only about two years since the South Jackson mine was in operation.

Sutter Creek, January 19.

WEAVERVILLE. Conditions at the Lagrange hydraulic mine are anything but favorable. On the 19th the machine-shops were destroyed by fire; a landslide broke a good deal of flume; and cold has frozen many things.

YREKA. Charles H. Hawkins has brought suit against George A. Milne for $20,000 damages. He alleges that Milne dumped rocks and tailing to a depth of 20 ft. and 200 ft. long on his mine. During the trial Milne introduced mining location notices to show that Hawkins does not own the land upon which the debris was dumped.

GEORGIA

DAHLONEGA. The past year is considered by the *Echo* to have been a busy one in this gold district, especially in metallurgical improvements at the Crown Mountain and Toledo mines. Several placer mines had a good season. Prospecting continues for other minerals.

IDAHO

LENIA. The Idaho Gold & Ruby Mining Co., operating a placer property at this place in Boundary county, has bought in San Francisco 3000 ft. of pipe and 6 giants, costing over $12,000. The head will be 420 ft. The sluicing plant is to have a daily capacity of 25,000 cubic yards.

MISSOURI

JOPLIN. Prices for blende ranged from $60 to $75 per ton last week. The output of the region was 7341 tons of blende, 142 tons of calamine, and 892 tons of lead, averaging $70, $40, and $87 per ton, respectively. The total value was $597,864.

MONTANA

BUTTE. On the 2400-ft. level of the Davis-Daly there is 11 ft. of ore assaying 35% copper and 32 oz. silver per ton. The minerals are bornite and glance. For 115 ft. driven on this level, 85 ft. assays 12%.

HELENA. The Scratch Gravel Mining Co. has bought a large building, erected some time ago for the treatment of zinc ore, and will install machinery to treat its ore. Development of high-grade gold ore continues to a depth of 400 feet.

NEVADA

ELY. In its last quarterly statement for the county assessor, the U. S. Tungsten Corporation announces that 457 tons of ore treated yielded $298,742. The profit was $125,762, and tax on 80% net $1573. The plant did not work in the December quarter, but may resume in the spring.

A shortage of coal is curtailing operations of the Nevada Consolidated. The weather is extremely cold.

LOVELOCK. The St. Anthony tungsten mines and mill near Toy have been closed indefinitely.

TONOPAH. Last week's production from 9 mines totaled 9409 tons, valued at $169,362. During December the Belmont yielded a profit of $114,836 from 10,204 tons; and the Jim Butler $22,508 from 2601 tons.

VIRGINIA CITY. In sending out an assessment (10c. per share) notice, the Mexican company gave the following information:

"The work of lowering the water from the 2700 to the 2900-ft. level of the north-end mines was commenced a short time ago, the pumps being lowered in the winze sunk many years ago on the south line of the Mexican mine. Most satisfactory progress has been made, the water having been lowered nearly 100 ft. at this writing (January 9), the lowest point it has stood in the Comstock mines for 32 years. Owing to the fact that the winze has to be changed with depth from one of three small compartments to one of two large compartments, progress is slower, but the ability of the electric pumps to handle the water is amply demonstrated. Beginning with January 1 has been commenced the installation of a new and more powerful electric hoist at the Union shaft, the old one proving too weak for the work since the shaft was opened to the 2700-ft. level. It is now the deepest shaft in Nevada, but there is no doubt that the new hoist will easily cope with the work. This is of course done jointly by the Mexican, Union, and Sierra Nevada companies, the owners of the shaft, each company paying one-third. The equipment has been maintained in first-class condition. There are mining supplies and cyanide on hand all paid for worth upwards of $30,000 and the mill is ready to start at a day's notice on Mexican ore when developed, or on ore from the neighboring mines. In this connection shareholders will do well to remember that there will shortly be entered country that is absolutely unexplored. The management has never doubted the fertility of the Comstock in depth, and with modern methods, both heat and water can easily be mastered if the funds are supplied. With silver going up and water going down the company fails to see why any shareholder should feel anything but encouragement."

NEW MEXICO

(Special Correspondence.)—The United States Copper Co., owner of the Philadelphia mine at Hanover, has recently acquired the Hardscrabble group of copper and silver properties in the Pinos Altos district, 1½ miles north of Pinos Altos and 9 miles north-west of Silver City. The capital of this company has been increased $500,000 to $1,500,000. The president, J. W. McAlpine, recently arrived from the East, and plans for extensive development are now under way. Work has already been started at both Hanover and Pinos Altos. At the latter place two vertical shafts, 4 by 8 ft. in the clear, have been started and will be sunk 200 ft. Orders for hoists, air-compressors, drills, etc., have been placed, and the company hopes to have machinery installed and operating by spring.——H. W. Kitson, representing Eastern and Western capitalists, has been in the district for the past two weeks, acquiring 90-day options on 50 claims for examination. The holdings taken over by the U. S. Copper Co. and those under option to Mr. Kitson, are in a new district, partly developed, but showing good indications.

It is said that the flotation plant being installed by the Empire Zinc Co. at the Cleaveland mine will not be completed until next summer. The new engine, the second, is being installed, and with this additional power the mill will be operated three shifts. It is estimated that with flotation machines the mill will have a capacity of 35 tons an hour.

The El Paso Mining Co., which took over the Stauber and Wright mill and the lease and bond on the Savanna holdings, is increasing the capacity of the mill from 35 tons to 100 tons per day, adding flotation. This mill operates the only Huff electro-static separator in this district.

The Kept Woman, a patented mining claim belonging to A. Espelen, and the Jupiter claim owned by L. A. McCarty, the latter joining the former on the south, were purchased on January 10, by Oliver Krull and J. C. Rumball. The Kept Woman has two shafts down about 100 ft. each, connected by a drift, and shows good ore. A small mill was erected some time ago, but was not a success. The new owners are practical men as well as mining engineers, and announce that they will begin active development early in February. They also contemplate re-modeling the mill and adding a flotation annex, the mill to have a capacity of 25 tons per day to start with. Krull and Rumball are from old Mexico, Mr. Krull having been superintendent of the Rio Tinto mine at Terrazes, Chihuahua; and Mr. Rumball, who is a chemist, owning and mining property at Batopilas, Chihuahua.

The present local activity should make Pinos Altos a lively place this year.

Pinos Altos, January 9.

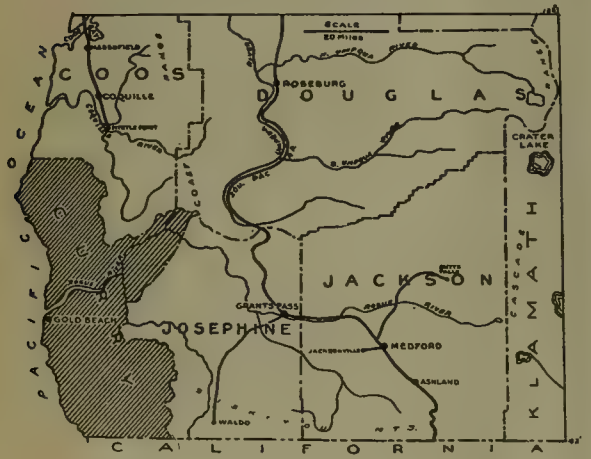
(Special Correspondence.)—On January 1 the Oaks company

paid its second dividend of 1% on preferred stock issued. Shipment of ore to custom mill from the Eberle mine continued during the week.——Campbell & Dempsey, owners of the Golden Bar group in the extreme north end of this district, have run a 248-ft. cross-cut, and are just getting into the vein, which shows high-grade ore on surface.——At the Last Chance mine, the Mogollon Mines Co. has installed timbers and track for skip to the 900-ft. level. The entire shaft will be completed some time in January, giving additional capacity for hoisting and development.——An assistant in the State Engineer's Office is making regular trips here, checking water readings on streams in the vicinity which have been appropriated by local interests with a view of installing hydro-electric power-plants in the early future.

Mogollon, January 9.

OREGON

In the October, 1916, 'Mineral Resources of Oregon,' published by the Oregon Bureau of Mines and Geology, G. M. Butler and G. J. Mitchell give a preliminary survey of the



PART OF OREGON, SHOWING CURRY COUNTY.

geology and mineral resources of Curry county. The text covers 132 pages, with 41 illustrations. Curry county lies in the south-western corner of Oregon, bounded on the west by the Pacific Ocean. Its length is 66 and width 36 miles. The area is mountainous. Gold deposits consist of veins, stream placers, and beach placers. There are occurrences of copper, iron, chrome, platinum in the placers, coal, borax, and quicksilver.

(Special Correspondence.)—Albert Geiser and partners have made one of the richest strikes of gold in Baker county in years at the old Connor Creek, as mentioned in the PRESS of January 6. After doing dead work for two years the vein was cut in the upper adit. It is 5 ft. wide, having a high-grade streak from 6 to 8 in. Some of it is so rich that it has been kept in the safe and is to be melted into bullion at the mine; for this purpose Mr. Geiser sent to Denver for a melting-furnace. The rest of the vein will average from $30 to $40 per ton. The ore is a white quartz containing no sulphide. The shoot has been driven on for 100 ft. and a raise started. Two lower adits are being driven to cut the ore at depth. A 10-stamp mill is crushing the ore. This mine is one of the oldest in the State, being first worked in 1876, and is credited by some with a production of over $3,000,000. The present owners are not working the old vein, but cross-cut to another that from surface indications was thought to exist in this ground.

In the Greenhorn district, E. E. Petty and Henry Abel have a good showing on their Red Bird claim, extracting and milling some high-grade gold ore. Across Olive creek from the Red Bird, Harvey Abel and Abe Abel are driving an adit in good ore on the same vein.

The Rainbow mine of the Commercial Mining Co. is keeping up a steady production from good ore. Thos. Borman has recently been appointed mill superintendent.

The Cornucopia district is attracting a great deal of attention due to the fine record of the Baker Mines and the Cornucopia Mines companies, which have the best gold mines in the State. The Queen of the West started operations again last summer. F. S. Baillie, former manager of the Columbia mine, is now manager of the Baker; Robert Betts is manager of the Cornucopia. Stages run to Cornucopia from Baker and Robinette.

The Iron Dyke mine near Homestead, now a large copper producer, had a good year and is at present employing a large crew.

M. F. Wyatt of Cottage Grove reports fine results on his claims in the Bohemia district, out from Cottage Grove. Samples of copper-zinc ore from two veins that were cut in the upper adit assay well. The veins are parallel, 20 ft. apart, and each is 5 ft. wide.

Victor Chapman of Eugene has completed work on the Highland group and reports satisfactory results. He and others are working on a porphyry dike that pans well in free gold, and gives good assays. The Highland is on the north fork of the Willamette river, out from Oakridge.

Eugene, January 12.

UTAH

ALTA. About 800 tons of ore was shipped out of the district last week, between 35 and 40 teams being occupied in this work in Little Cottonwood canyon.

AMERICAN FORK. According to J. H. Weber, well-known at Salt Lake City, who returned from an inspection of various properties in the district, it is his opinion that the American Fork Canyon region will be heard from in a few months as one of the big producing sections of the State, as it is even now one of the most active in the development of proved ground and the prospecting of territory that is accounted favorable for development.

GOLD HILL. The new Deep Creek railway is expected to reach this place early in February. The Pole Star copper mine has shipped the first car of ore over the road, auto-trucks carrying the ore to the first siding.

NEPHI. In Juab county two drill-rigs are boring for oil on the eastern anticline. Several years ago two wells were put down 2000 ft., but results were never made known. Mt. Nebo No. 2 well struck oil and gas of high gravity. The Utah Petroleum Co. of Delaware is doing the new drilling.

PARK CITY. Early in February the Judge Mining & Smelting Co. expects to have its zinc-plant at work.

WASHINGTON

NORTHPORT. To connect its lead mine with the Great Northern line at Northport or Boundary, a distance of 15 miles, the Electric Point Mining Co. may construct a railway costing $200,000. The monthly haulage of 2500 tons costs $5 per ton. Conditions at the mine are good. Roy Young is general manager.

TACOMA. Additions to the A. S. & R. smelter here include a 600-ft. stack, 51 ft. diam. at the base and 30 ft. at the top. The Denny Renton Clay & Coal Co. of Seattle secured the contract for over 2,500,000 acid-resisting vitrified brick for the chimney.

The tide-flat plant of the Bilrowe Alloys Co. is to spend $100,000 in additions, including four furnaces. The present plant consists of crusher, rolls, jigs, tables, and 3 electric furnaces, producing ferro-manganese, also concentrating and cleaning tungsten ores.

CANADA

British Columbia

Silverton. The 100-ton mill of the Galena Farm mill has operated a year, according to the manager, P. W. Clark. The mill superintendent, G. A. King, states that the plant is saving 90% of the lead on the tables and 80% of the zinc by flotation. The lead concentrate has a content of 70% and 80 oz. of silver per ton, the zinc concentrate 47% of that metal and 20 oz. of silver. By installing more tables and flotation machines the capacity is to be raised to 125 or 150 tons daily. Crushing is done by rolls and Huntington mills. On account of water shortage treatment has been suspended until March. The feed delivered to the mill contains 12% lead and 18% zinc, according to John Bresnahan, the mine superintendent. These contents are fairly representative of the body which has an average width of 8 to 9 ft. The shoot has been followed by drift for 30 ft. at a depth of 100 ft. It is being mined through a tunnel that attains a depth of about 250 ft., where connection is made with the shaft.

Ontario

Cobalt. During December the Nipissing company produced silver worth $259,836 from 80 tons of rich ore and 6162 tons of low-grade ore. The refinery shipped 396,879 oz., partly custom metal. Development generally was favorable.

Porcupine. Enlarged and more economical operation will follow consolidation of the McIntyre, McIntyre Extension, and Jupiter mines, in charge of R. J. Ennis. The new aerial tram across Pearl lake is ready for ore at the rate of over 500 tons daily. A central hoisting shaft is to be arranged. On the 1000-ft. level the ore-shoot is from 20 to 40 ft. wide, assaying $20 per ton. This has been opened for 550 feet.

MEXICO

In his annual address to shareholders of the Santa Gertrudis company in London, the chairman, F. W. Baker, said:

"It is a matter of the utmost regret to the directors to realize that, so far from conditions in Mexico having improved during 1916, the reverse is actually the case. The labor supply is not only insufficient, it is inefficient in quality —a fact that has not deterred the more turbulent members from a ceaseless agitation for higher pay, until we are now paying a higher wage than was the case previous to the present revolutionary period. The political outlook is still most uncertain, and even if such a discussion could be regarded as wise, or politic, I doubt if it is possible for any of us to attempt to forecast the future. With the exception of certain delays incidental to the irregular running of the railways, and of the difficulties above mentioned in connection with the labor supply, all of which we share in common with other concerns in Mexico, we have been free from many trials and troubles experienced by some other companies. For this the thanks of the shareholders are due, to a great extent, to the manager and his staff for tactful and able handling of many difficult situations."

Hidalgo

Pachuca. The Santa Gertrudis company reports as follows for the year ended June 30, 1916:

The disturbed political situation continued to affect adversely the regularity and scale of operations. Work was confined to development and ore production. No important equipment was required. Labor and supplies were scarce and inadequate, but improved compared with the previous year. The currency situation required close attention to avoid losses, owing to the extreme and rapid fluctuations in the value of the peso. Development amounted to 14,865 ft. Water pumped averaged 875 gal. per minute. Reserves amount to 1,214,000 tons, containing 74,405 oz. gold and 14,881,090 oz. silver. Operation in 1916 varied from 20 to 79%, an average of 56.6%. The new mill treated 227,616 tons of ore, assaying $8 per ton, with 92.85% recovery. A dividend of 24c. per share absorbed $360,000.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

A. W. Allen is at New York.

W. H. Lanagan was in New York recently.

Walter Strache has returned to New York from Chile.

W. R. Feldtmann has returned to London from West Africa.

Edgar A. Collins is visiting the copper districts of Arizona.

R. P. Lawrence, manager for the Austral Bolivia tin mines, in Bolivia, is here.

Albert Burch has returned from Butte and will proceed shortly to Colorado.

W. Shellshear, formerly at Broken Hill, has joined the staff of the Burma Corporation.

A. W. Freeman, of Sydney, Australia, was in San Francisco and is now on his way to New York.

W. C. Robotham has been appointed superintendent of the Banner mine, near Oroville, California.

Algernon Del Mar passed through San Francisco on his way from eastern Oregon to Los Angeles.

H. W. Gepp, of the Amalgamated Zinc, Broken Hill, has arrived in Australia from the United States.

F. P. Burrall of New York, who has been at Dawson during the past season, is wintering in the United States.

R. Clyde Cameron is general superintendent of the Primos Exploration Co.'s Copeland mine, near Boulder, Colorado.

G. G. Thomas, former manager of the Dome Lake and Hudson Bay mines, in Ontario, has opened an office at Toronto.

Sidney J. Jennings was injured, fortunately not seriously, in a railway accident near Durango, Colorado, on January 21.

Hugh Rose, manager of the Santa Gertrudis mine, Pachuca, Mexico, is in San Francisco, and is likely to make it his headquarters.

F. L. Stack, until recently with the Morochocha Mining Co., Peru, has changed his address to Fomento, province of Santa Clara, Cuba.

James Irving, of the Los Angeles firm of assayers bearing his name, has removed his laboratory to 702 South Spring street, Los Angeles.

William Motherwell has opened an office as consulting flotation engineer at Nelson, B. C., and at present is at the Blue Bell mine at Riondel.

Charles E. van Barneveld, supervising mining engineer and metallurgist to the U. S. Bureau of Mines, was here on his way from Salt Lake City to Tucson.

Carl J. Trauerman, of Butte, Montana, is on a trip to Chicago, Pittsburg, and New York. He can be reached by addressing the A. I. M. E. headquarters, New York City.

Myron L. Fuller, of the Associated Geological Engineers, read a paper entitled 'The Appalachian Oil Fields' at the meeting of the Geological Society of America of December 27-29.

G. S. Rice, of the U. S. Bureau of Mines, has been investigating the Crow's Nest Pass Coal Co.'s troubles in British Columbia, with W. Fleet Robertson and Thomas Graham of the Provincial Department of Mines.

Elisha W. Slater, who for years, in the earlier days, had been a prominent mine manager and operator in Butte county, California, died at Oroville January 19 in his 89th year. His mining activities were mostly river and hydraulic work.

Forty-five men have enrolled in the 20th annual three-months' mining session at the College of Mines, University of Washington, Seattle. Their ages vary from 21 to 56 years, averaging 32 years. All but ten of the men have had mining experience. They register from all parts of the Pacific Coast, from Arizona to Alaska. Quartz miners are in the majority, but several placer miners are present, also a few coal men.

THE METAL MARKET

METAL PRICES

San Francisco, January 23.

Antimony, cents per pound	12
Electrolytic copper, cents per pound	35
Pig lead, cents per pound	7.75— 8.75
Platinum, soft and hard metal, per ounce	$85—91
Quicksilver, per flask of 75 lb	$80
Spelter, cents per pound	13
Tin, cents per pound	44
Zinc-dust, cents per pound	18

ORE PRICES

San Francisco, January 23.

Antimony, 50% metal, per unit	$1.00
Chrome, 40% and over, f.o.b. cars California, per ton.	15.00
Magnesite, crude, per ton	6.50— 9.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO_3, per unit	18.00—20.00

Magnesite is in moderate demand, there being inquiries for the high-grade iron-free mineral, and also for the iron-bearing mineral. These two varieties are used for wholly different purposes, and magnesite suitable for one use may be wholly unfitted for other uses.

Bulletin 111 of the U. S. Bureau of Mines, entitled 'Molybdenum: Its Ores and Their Concentration,' with a discussion on markets, prices, and uses, by Frederick W. Horton, should be secured by miners interested. Its price is 30 cents.

The concentrating plant at Renfrew, Ontario, is paying $1.90 per lb. for concentrate containing 80% MoS_2. Penalties are imposed for copper and bismuth. Ore carrying from 2 to 3% MoS_2 receives $14 per unit.

In time of peace Germany was the largest consumer of tungsten ore, and it is probable that when peace succeeds war Germany will again require a large amount of the ore. Although Great Britain has taken steps to reduce tungsten ores at home, she is unable to get the desired ore supply to keep the works employed, and the present outlook is that not only will the present price be maintained, but it is thought likely that it may be somewhat higher.

New York, January 19.

Antimony: This ore is scarce. For early delivery $1.50 per unit has been offered but without success. Chinese and Japanese grades are firm at 14.25 to 14.50c., duty paid.

Tungsten: While it is stated that $17 has been paid in this market, it is known that Eastern consumers have obtained ore for $16 in the past few days. Both foreign and domestic consumers have bought.

EASTERN METAL MARKET

(By wire from New York.)

January 23.—Copper is firm but quiet. Lead is strong. Spelter remains quiet.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Jan. 17	75.00	Dec. 12	75.37
" 18	75.37	" 19	76.35
" 19	75.87	" 26	76.05
" 20	75.87	Jan. 2	75.37
" 21 Sunday		" 9	75.28
" 22	76.62	" 16	74.66
" 23	76.50	" 23	75.87

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90	47.52	63.06
Feb.	57.53	48.45	56.74	Aug.	54.35	47.11	66.07
Mch.	58.01	50.61	57.89	Sept.	53.75	48.77	68.51
Apr.	58.52	50.25	64.37	Oct.	51.12	49.40	67.86
May	58.21	49.87	74.27	Nov.	49.12	51.88	71.60
June	56.43	49.03	65.04	Dec.	49.27	55.34	75.70

The stock in Bombay December 23 was 2200 bars as compared with 1800 bars the previous week.

The stock in Shanghai on December 23, 1916, consisted of about 23,900,000 oz. in 'sycee,' and $16,600,000, as compared with about 22,800,000 oz. in 'sycee' and $16,400,000 on December 16, 1916.

ALUMINUM

The offering at New York of a few hundred tons by dealers and second-hands has brought about an easier tendency, and No. 1 virgin aluminum, 98 to 99% pure is quoted at 57 to 61 cents.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Jan. 17	29.00	Dec. 12	34.87
" 18	29.25	" 19	34.04
" 19	29.50	" 26	31.55
" 20	29.50	Jan. 2	29.90
" 21 Sunday		" 9	28.20
" 22	29.50	" 16	28.33
" 23	30.50	" 23	29.34

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	14.21	13.60	24.30	July	13.26	19.09	25.66
Feb.	14.46	14.38	26.62	Aug.	12.34	17.27	27.03
Mch.	14.11	14.80	26.65	Sept.	12.02	17.69	28.28
Apr.	14.19	16.64	28.02	Oct.	11.10	17.90	28.50
May	13.97	18.71	29.02	Nov.	11.75	18.88	31.95
June	13.60	19.75	27.47	Dec.	12.75	20.67	32.89

Granby Consolidated in December produced 3,219,022 lb. of copper.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Jan. 17	7.65	Dec. 12	7.73
" 18	7.70	" 19	7.69
" 19	7.75	" 26	7.50
" 20	7.75	Jan. 2	7.49
" 21 Sunday		" 9	7.50
" 22	7.75	" 16	7.50
" 23	7.75	" 23	7.72

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80	5.59	6.40
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67	6.28
Mch.	3.94	4.04	7.26	Sept.	3.82	4.62	6.86
Apr.	3.86	4.21	7.70	Oct.	3.60	4.62	7.02
May	3.90	4.24	7.38	Nov.	3.68	5.15	7.07
June	3.90	5.75	6.88	Dec.	3.80	5.34	7.55

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Jan. 17	10.00	Dec. 12	12.25
" 18	10.00	" 19	11.13
" 19	10.00	" 26	10.00
" 20	10.00	Jan. 2	9.75
" 21 Sunday		" 9	9.66
" 22	10.00	" 16	9.37
" 23	10.00	" 23	10.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75	20.54	9.90
Feb.	5.22	9.05	19.99	Aug.	4.75	14.17	9.03
Mch.	5.12	8.40	18.40	Sept.	5.16	14.14	9.18
Apr.	4.98	9.78	18.62	Oct.	4.75	14.05	9.92
May	4.91	17.03	16.01	Nov.	5.01	17.20	11.81
June	4.84	22.20	12.85	Dec.	5.40	16.75	11.26

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending Date.			
Dec. 26	80.00	Jan. 9	80.00
Jan. 2	80.00	" 16	80.00
		" 23	80.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	39.25	51.90	222.00	July	37.50	95.00	81.20
Feb.	39.00	60.00	295.00	Aug.	80.00	93.75	74.50
Mch.	39.00	78.00	219.00	Sept.	76.25	91.00	75.00
Apr.	38.90	77.50	141.60	Oct.	53.00	92.90	78.20
May	39.00	75.00	90.00	Nov.	55.00	101.50	79.50
June	38.60	90.00	74.70	Dec.	53.10	123.00	80.00

TIN

Prices in New York, in cents per pound.

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60	37.38	38.37
Feb.	39.76	37.23	42.60	Aug.	50.20	34.37	38.88
Mch.	38.10	48.76	50.50	Sept.	33.10	33.12	36.66
Apr.	36.10	48.25	51.49	Oct.	30.40	33.00	41.10
May	33.29	39.28	49.10	Nov.	33.51	39.50	44.12
June	30.72	40.26	42.07	Dec.	33.60	38.71	42.55

PLATINUM

Price of platinum, New York, is $90 per ounce for soft metal and $96 for hard.

Eastern Metal Market

New York, January 17.

The metals presented a ragged aspect just prior to the appearance of the Entente Allies' reply to Germany, but the publication of the note relegating peace to the uncertain future stiffened all prices, caused concessions to be withdrawn, and put a stop to short selling.

The trade is in the dark with regard to what is going on at London because of the extent to which cables are delayed. None was received yesterday. The last information received indicated that copper and spelter were lower.

On January 9 and 10 a metal-selling house alleged to have German affiliations sold over 500 tons of January, February, and March spelter on the floor of the New York Metal Exchange at concessions, doing so openly, and inviting the presence of those who might buy. This may have been done because of a sincere belief that peace was near at hand, although it is suggested that the real purpose may have been the psychological effect on the trade at large, which seems a little far-fetched. Having sold the metal referred to, the seller made no further offerings. The exports of zinc are below what they should be to absorb their share of production.

Prompt lead is scarce and higher.

Tin has advanced, and is none too plentiful for early delivery.

Antimony is firm, and aluminum lower.

The iron and steel markets show a quieter tendency as to new business, although specifications against contracts are as heavy as ever. There is an enormous demand for standard low-phosphorus and Bessemer pig-iron, for both export and domestic consumption, the buyers being willing to contract for deliveries into 1918. Consumers of foundry-iron, on the other hand, are unwilling to contract into the last half at present prices. The railroad congestion appears to be a little relieved in the East, although unimproved in the Middle West. Canada is looming up as a large purchaser of steel products, as well as of machinery. She has about reached the limit of her steel-producing capacity. The Imperial Munitions Commission has placed an order for ten 8-ton Heroult electric furnaces for a plant to be built at Toronto. The Commission is building an arsenal at Lindsay, Ontario, which will consist of 60 buildings, on the construction of which 1400 men are now at work.

Deliveries of metal-working machinery are somewhat easier, especially those not classed as strictly standard.

COPPER

Prior to the publishing of the Entente Allies' reply to the German peace note the market sagged to an extent which was a cause of worriment, but following the reply, which seemed to make peace more remote than ever, the market took a turn upward, and in the past two or three days it has been growing stronger. On Monday and Tuesday of this week (January 15 and 16) the market was a puzzle, inasmuch as bids were declined, sellers refused to make prices, and with it all there was no great desire to buy. Under the circumstances, all prices were rather nominal than otherwise. It was reported January 10 that some large foreign business was under negotiation, but tne majority of the trade did not take the rumour seriously, knowing that it came from sources close to Wall Street, and probably represented an attempt to bolster up the stock market. At the same time, it was admitted that there might be some ground for the story. On that day March, April, and May electrolytic was offered at 26c., but failed to attract buyers. Even a large munitions maker, known to be looking for copper, could not be interested, as he believed that he could do better by waiting. Then came the Allies' note strengthening the entire market, and the quotations for the months referred to jumped to 27 to 27.25c., delivered in Naugatuck valley. The views of the munitions maker referred to underwent a change and he asked a renewal of the offer at 26c. But the views of sellers had changed also, and the munitions maker did not get the copper. Yesterday spot electrolytic was quoted at 29c., and some special Lake sold at 29.50c. Second quarter electrolytic was quoted yesterday at 27.50 to 28c. But little is available for the first quarter, and not a great deal for the second. Selling short has entirely ceased, and second-hands have withdrawn their concessions. The London market is difficult to understand, likewise the attitude of the British government. The quotations cabled on January 12 did not reach New York until January 15, and yesterday (January 16) no cables were received on any of the metals. They are undoubtedly being held up by the censor. The last cable received put electrolytic at £141, against £143 a week ago. The exports during the period from January 1 to 17 totaled 11,591 tons, which is not large.

ZINC

Unusual influences appear to have been at work in this metal. As stated a week ago, 120 tons, including January, February, and March deliveries, were sold on the Exchange, January 9, at a concession from the market price. On the following day 360 tons more was sold for the same deliveries, 120 tons of each, at prices representing a decline of ¼c. from those of the preceding day. All of this selling was done openly by a house witb alleged German affiliations. Delayed cables disclosed that the London market was weak on the day of sale under pressure to sell. No cable was received yesterday, but the last information to arrive put spot zinc at London at £45 10s., against £50 5s. a week previous. Altogether it seems certain that a world-wide effort to lower metal prices has been made. Following the Allies' note the market stiffened, with the result that spot prime Western was quoted yesterday at 10c., New York, and 9.75c., St. Louis. February was around 9.62½c., St. Louis, and March around 9.37½c. Second quarter was near 9c., St. Louis. The exports were light, amounting January 1 to 17, to 3133 tons. Authorities point out that the exports should be between 17,000 and 18,000 tons per month, if the large production is to be absorbed. Hopes of big buying by the Entente Allies, commensurate with their purchases of copper, continue to be entertained. A fair domestic business was done last Friday and Saturday, and Monday of this week, but yesterday (January 16) the market was quieter. Sheet zinc is unchanged at 21c., carload lots, f.o.b. mill, 8% off for cash.

LEAD

Transportation difficulties have been the cause of manufacturers running short of lead, and they have entered the market for spot supplies, only to encounter what appears to be a *bona fide* shortage. This, and the strength imparted by the more remote prospects of peace, have caused prices to advance. For January delivery, 7.65c., New York, and 7.50c., St. Louis, was asked by independent interests yesterday (January 16). The quotation of the leading interest, nominal inasmuch as it is only used as a basis for establishing an average price, was 7.50c., New York. Early last week the market was weak, substantial concessions being made on prompt. At this writing there is no pressure to sell, holders expecting a stronger market, while consumers are wary of buying because they have in mind the recent slumps that the market has endured. The exports, January 1 to 17, total only 330 tons. No cable was received yesterday, but the last price received from London left spot unchanged at £30 10s.

Manganese in 1916

Preliminary estimates by D. F. Hewett, of the U. S. Geological Survey, show that the production of manganese ore in 1916 was about 27,000 tons, the greatest since 1888 and nearly three times that in 1915, which was 9709 tons. The estimate does not include manganiferous-iron ores that contain less than 40% of manganese, but it is probable that the production of ores of this class also was much greater than in 1915. This output has come largely from seven States, and the order in production will probably prove to be as follows: California, Arkansas, Arizona, Georgia, Virginia, Utah, Colorado. This order is interesting, because this is the first year in which a Western State remote from the steel-producing centres has contributed the largest amount of manganese ore. The activity among manganese mines in California is due largely to the market for ores provided by the Noble Electric Steel Co. at Heroult. It is not yet possible to state the production of high-grade ores adapted for use in dry batteries, but reports indicate that it will exceed 2500 tons and therefore be five times that in 1915. Ores of this class are now produced in Arizona, California, Utah, Colorado, and Virginia, but the amount produced is still scarcely one-tenth the normal demand.

The prices paid for manganese ore adapted to the manufacture of ferro-manganese rose from a maximum of $22.50 for 50% ore in 1915 to $32.50 in March, 1916. Except for minor fluctuations, which depended on temporary variations in demand, prices were nearly constant until the last month of the year, when sales at prices as high as $39 for 50% Indian ore were reported. There were rumors that a contract for the delivery of 200,000 tons of Brazilian ore during 1917 was placed at $23 per ton f.o.b. Brazilian port, from which the freight rate to Baltimore is $12 per ton. Ore adapted to the manufacture of dry batteries (containing 80% of manganese di-oxide and less than 1% of iron) continues to sell for about $85 per ton.

Imports of manganese ore for the first ten months of 1916 amounted to 495,299 tons, of which 401,177 tons came from Brazil. For the same period of 1915 Brazil supplied 181,258 tons out of the total of 192,286 tons. There is a prospect, therefore, that the imports for the entire year will prove to have been almost double those of 1915—320,778 tons. Considering the small part of the demand that was supplied by Brazil during the eight years prior to 1914, it is re-assuring to know that the deposits of that country can be made to yield such enormous quantities of ore. Imports from India, Cuba, Panama, and Japan were also greater than in 1915.

Imports of ferro-manganese for the first 11 months of 1916 were 73,435 tons, which is nearly 50% more than for the corresponding period in 1915, though bearing a smaller ratio to the domestic production. Prices reached the highest figures ever recorded in the United States in April, 1916, when, it is reported, $400 per ton was paid for a small lot for immediate delivery. For the remainder of the year the price declined steadily to $160 per ton in October, then rose to $175 again in December. The price of spiegeleisen carrying 20% of manganese ranged from a maximum of $52 in July to $40 in December.

An important consequence of the prevailing high prices of manganese alloys is the attempt on the part of steel-makers to use substitutes. The extent to which substitutes for manganese in steel may be used has not been determined, but experiments by several steel works show that an alloy of iron, carbon, and titanium may be satisfactorily used to replace a part of the ferro-manganese commonly added.

Although a number of mines in Virginia, Georgia, and Arkansas were re-opened during 1916, the greatest activity is reported among mines in California, Arizona, Utah, New Mexico, and other Western States. This is due in part to the operation of electric reduction plants in California and Washington, but more largely to the low percentage of iron in some of the Western ores. Few Eastern mines that operate residual deposits can produce at a profit in large quantities ore that contains less than 1% of iron, and therefore most of the Eastern mines ship their product to Eastern furnaces to be reduced to ferro-manganese. The inaccessibility of most Western deposits makes it unprofitable to ship ore to Eastern makers of ferro-manganese, even at the high prices they are offering for manganese ore. On the other hand, many Western deposits are known and more have been discovered during recent years, which are capable of producing manganese ore with less than 1% of iron. At prevailing prices for such ores, they may be profitably shipped as far east as New York. There is a prospect at present that several Western mines may be able to ship high-grade ores to Eastern markets even when prices recede to the level of years prior to 1914.

Sulphuric Acid in 1916

The production of sulphuric acid in the United States in 1916 was much greater than in 1915. The estimated production of sulphuric acid of strengths of 50°, 60°, and 66° in 1916, expressed in terms of 50° acid, is 4,475,000 tons, an estimated increase over the production in 1915 of 600,000 tons, or more than 15%. The increase was distributed about equally between acids of strengths of 50° and 60°, as there was a small decrease in the production of acid of strength of 66°. The most notable feature in the sulphuric acid industry was the enormous increase in the production of acids of strengths greater than 66°. The estimate shows a production of these stronger acids of over 1,000,000 tons as against a production of less than 200,000 tons in 1915. It is not feasible to express the amount of these higher acids in terms of 50° acid; therefore the total given for them is in addition to the total given for acids of strengths of 66° or less. The estimated output of acids of strengths of 60° and 66° includes by-product acid produced at copper and zinc smelters. The output of acid so produced in 1916, expressed as 60° acid, amounted to nearly 950,000 tons, or practically the same as in 1915. However, over 110,000 tons of acid of higher strengths was produced at these smelters, a quantity nearly double that produced in 1915.

The market conditions throughout the country are reported to have been on the whole better than in 1915, and the value of the product will probably be somewhat higher than it was even during that year of high prices.

The estimates are based on returns received by Philip S. Smith.

The U. S. Bureau of Mines, has just issued Bulletin 111, 'Molybdenum, Its Ores and Their Concentration, with a Discussion of Markets, Prices, and Uses.' The author is Frederick W. Horton. The Bureau has been obliged to affix a price of 30 cents on this useful publication.

PIG-IRON PRODUCTION of Canada during 1916 is estimated at 1,046,185 tons. The steel output was 1,270,969 tons. These are increases of 28% and 42%, respectively. Electric furnaces made 39,098 tons of steel castings and ingots, against 61 tons in 1915.

CHROMIC-IRON ORE production of the United States in 1916 was over 35,000 tons, against 3281 tons in 1915. Most of this was from California—Oregon, Maryland, and Wyoming contributing. Imported ore averaged $12.66 per ton.

COAL PRODUCTION of the United States in 1916 was 597,500,000 tons, an increase of 14%.

COKE MADE in the United States in 1916 was 54,300,000 tons, an increase of 30%.

Mining and Scientific Press

Edited by T. A. RICKARD

Volume 114
Number 5

SAN FRANCISCO, FEBRUARY 3, 1917

15 Cents per Copy
$4 per Year

Line of 20-inch O. D. "NATIONAL" Matheson Joint Pipe Installed by a Copper Company in Western Arizona

¶ Extensive mining operations generally require many tons of pipe for various purposes.

¶ The installation shown in the illustration is a long distance from sources of pipe supply, and therefore "NATIONAL" Pipe was specified because it offers many advantages for this purpose.

¶ The new edition of "NATIONAL" MATHESON JOINT PIPE booklet contains illustrations from photographs of large installations in remote districts.

¶ A copy will be sent free on request to those whose letter-head of position would indicate a legitimate use.

NATIONAL TUBE COMPANY, General Sales Offices, Frick Building **Pittsburgh, Pa.**

District Sales Offices in the Larger Cities

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The Miami Appeal

PITTSBURGH COAL PRODUCTS COMPANY
PITTSBURGH, PA.

MAIN OFFICE AND WORKS
MONACA, PA.

November 29, 1916.

Oliver Continuous Filter Co.,
Market Street at First,
San Francisco, Cal.,

Gentlemen:-

This will confirm our telegram of to-day which reads as follows:-

"Filter delivered yesterday twenty-eighth. Many thanks for prompt shipment."

We feel that we are under obligation to yourselves and the Express Company for your most prompt action in handling this shipment. It hardly seems possible that a piece of equipment of this nature could be ordered on the 20th of the month at San Francisco, and delivered to us at Pittsburgh on the 28th of the same month. We are arranging to complete the installation as readily as possible, and will certainly avail ourselves of your further assistance as we may require the same.

We also acknowledge receipt of your letter of November 24th, enclosing invoice, packing list, and copy of operating instructions. These will have due attention. Again assuring you of our thanks for your cooperation in this matter, we are,

Yours very truly,

PITTSBURGH COAL PRODUCTS COMPANY,

Treasurer.

JGB/s

THESE TWO LETTERS TELL THE TALE

PITTSBURGH COAL PRODUCTS COMPANY
PITTSBURGH, PA.

UNLESS OTHERWISE INSTRUCTED ADDRESS ALL COMMUNICATIONS TO THE COMPANY AT MONACA PA.

MAIN OFFICE AND WORKS
MONACA, PA.

ALL AGREEMENTS ARE CONTINGENT UPON STRIKES, ACCIDENTS AND OTHER DELAYS BEYOND OUR CONTROL.

BELL TELEPHONE ROCHESTER 60 BEAVER VALLEY

January 10, 1917

Oliver Continuous Filter Co.,
403-Market Street,
San Francisco, Cal.,

Gentlemen:-

In pursuance to our correspondence at the time of the purchase of one 6x5-25 ton Oliver Continuous Filter, we beg to advise that we have now had this equipment in satisfactory service since about the middle of December. We are most gratified with the results obtained, both in labor saving and in increased efficiency.

Prior to the installation of this machine, we were losing from 30% to 36% Sodium Benzene Sulphonate in press-cake, and in addition to that, we were greatly handicaped by having insolubls Sulphates retained in our mother liquor. The loss in press-cake is now reduced to from 6% to 8% and will be still more out down, we believe, as our men more thoroughly master the use of the machine. The objectionable Sulphates are almost entirely eliminated.

As befor stated we are much pleased with the results obtained and we do not hesitate to say that the purchase of this equipment is one of the best investments we have made.

Yours very truly,

PITTSBURGH COAL PRODUCTS COMPANY,

Treasurer.

JGB:w

Oliver Continuous Filter Co.

501 MARKET ST. SAN FRANCISCO, CAL.

EDITORIAL STAFF:
T. A. RICKARD - - Editor
M. W. von BERNEWITZ
W. H. STORMS
Ass't Editors

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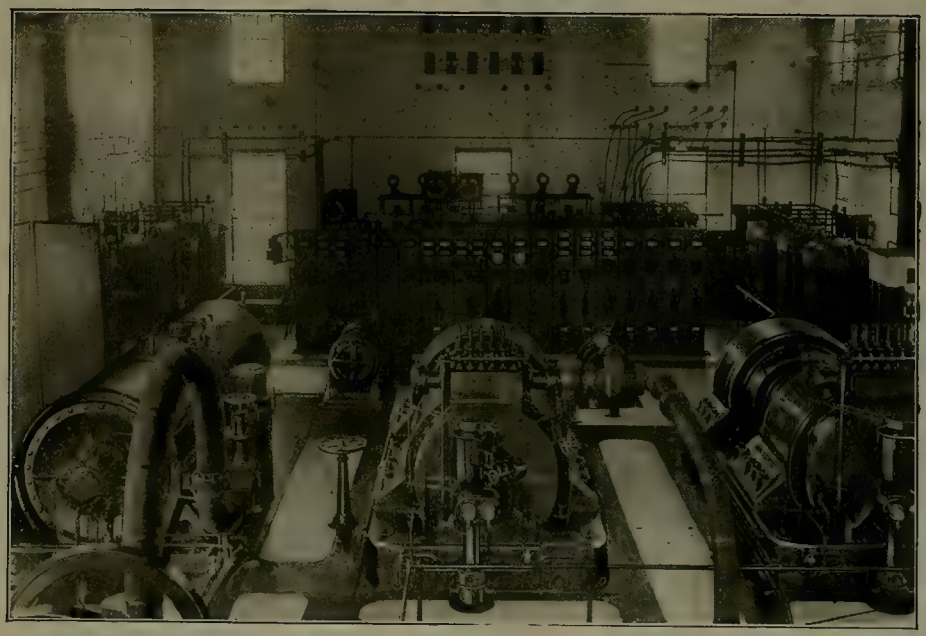

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EDITORIAL

T. A. RICKARD, Editor

WE are glad to say that the Randall rider to the Post-Office Appropriation Bill was defeated in the House of Representatives. This rider provided for a change in postal rates under a zone system like the one now applying to parcel-post matter. We discussed it in our last issue.

ON another page we publish an interesting letter on Chinese antimony, by Mr. K. C. Li, of the Wah Chang Mining & Smelting Co., the well-known dealers in Chinese antimony. We understand that the Canadian munition-makers have purchased a good deal of antimony on the New York market, and that the shortage of stock is favorable to the producer.

NO excuse, except improvidence, exists for the fact that the precious-metal mining industry should be crippled by the scarcity of cyanide. Why should we depend upon Germany or Glasgow for our supply of this necessary chemical when it can be made in unlimited quantity in the United States? We are paying $1.10 per pound while the mines in South Africa get all the cyanide they require for 18 cents per pound. We have ample water-power, a supply of potash salts exists in the Searles and Owens lakes, and plenty of sodium can be obtained from the waters of Salt Lake, not to mention the salt measures of New York and Michigan. Another example of unpreparedness.

FROM time to time we receive letters or calls from investigators of metallurgical processes, notably flotation. It is remarkable how many of them go to work enthusiastically and energetically to discover something new without having taken the pains to acquaint themselves with what has been done already in the particular branch of research to which they are devoting themselves. All sorts of men are playing with flotation without having read the technology of the subject and without any notion of the extent to which their ideas may have been anticipated by others, as recorded both in the technical press and in the records of the patent-office. Such procedure is not only unscientific, but unprofitable.

IN the *Daily Metal Reporter* we find timely advice and warning to the metal-producing industry in this country. Our contemporary lays stress on the fact that the Allied governments are unwilling to enter into new commitments on terms increasingly onerous, so that the purchase of metals is being curtailed. Moreover, the contraction of cargo-space and of facilities for shipping is decreasing deliveries to a serious degree. These are some of the reasons for stimulating the hope of peace. "Peace is very speedily becoming a bull argument," says the *Metal Reporter*. It looks as if the United States had obtained most of the prosperity incidental to the War and as if the humanitarian argument might now be strengthened by the enlightened selfishness prompted by economic facts.

WHAT comment is made on mining in the columns of the San Francisco press is usually sophomoric in style and substance. We read that a certain discovery of ore, quite fabulous, is "certainly of vast importance as bearing upon the truth, so often expressed in these columns, that the mineral wealth of California is as varied as it is unlimited, and that, despite the enormous quantities of ore already developed, we have as yet but scratched the surface of our metallic resources." These bromidic remarks will do nothing to enhance California's reputation as a mineral region, but we are willing to believe that they, and others like them, have often appeared in the columns of the *Morning Howl*.

THIS is not a political paper, it is a technical periodical, yet it is hard not to say something occasionally about the greater affairs of life. The suggestion is made in the *New Republic*—and it is a suggestion that many of us have discussed before now—to ask Congress to appropriate at least a hundred million dollars for the relief of non-combatants in the countries devastated by the war in Europe. At the same time an American commission should be created to strengthen the hands of the Americans doing the work of relief in Belgium, France, and elsewhere, thereby giving them some official standing. For this nation to give $100,000,000 for such a purpose would not be too much—nothing like too much—having regard to our wonderful gain in wealth since the War began. Moreover, such an act would strengthen the President's position as a peace-maker.

PUBLIC improvement in the Central American republics is generally undertaken and financed by American, English, German, or French capital, but occasionally the wealthy native engages in these enterprises on his own account. It is interesting therefore to note, in the December bulletin of the Pan-American Union, that a number of capitalists at Juticalpa, which is the metropolis of the Department of Olancho, Honduras, have organized a company to dredge the Patuca river, with a view to making it navigable for ocean-going

vessels. This is the largest river in Honduras and rises among high mountains near the centre of the country. The streams that unite to form the Patuca—notably the Guayape—have long been credited with a fabulous production of gold and they flow through great forests of valuable timber, including mahogany, rubber, and Spanish cedar, but unfortunately the river is not navigable for sea-going craft, nor can it ever be made so. It is full of dangerous snags, the current is swift, and the difference between the low stage of water and that of flood-time is not less than 25 feet. The scheme is impracticable, and this may explain why foreign capital is not interested in the proposed improvement. If the interior of Honduras could be reached easily—by a railroad, for instance—it would do much to bring into prominence the mineral resources of the region; these are not without promise, but under existing conditions they have no economic value.

ON another page we publish a short description of the Bunker Hill smelter, now in course of erection at Kellogg, Idaho. To Mr. Jules Labarthe, the designer, we are indebted for this sketch of the plant. It will be noted that the double-roasting system is to be applied on a part of the charge. Pre-roasting is necessary only on material high in sulphur, to obviate the formation of too much lead matte. The ore of the Bunker Hill & Sullivan mines contains only a trace of copper and is comparatively low in sulphur on account of the iron content being in the form of a carbonate, instead of a sulphide. At the Northport smelter the copper that formerly was lost is now being recovered by re-concentrating the copper in the lead matte until the proportion rises to 18 or 20%. The copper-lead matte is roasted, to be melted subsequently with silicious ore so as to make a lead bullion and a copper matte, the latter containing less than 8% lead, while the copper averages 40%. Of the lead in this matte about 60 to 70% is recovered as dust and sublimate in a bag-house or a Cottrell plant. In lead smelting it is essential to separate the by-products in marketable form. We note that in the Bunker Hill smelter the softening-furnaces serve to remove the copper, as dross, from the lead bullion; this dross is returned to the blast-furnace, where the lead is recovered as bullion and the copper as matte.

Cyanide

This chemical product is becoming more scarce every day. In small quantity it has been bought recently for $1.10 to $1.15 per pound, but only odd lots are available. Before the War the supply of cyanide required by American mills came mainly from Germany or Glasgow. The one source is sealed by the blockade and 4000 tons is said to be held at sundry European ports. The Scottish output has been commandeered for British use in South Africa, India, and Australia. Most of the cyanide consumed in this country used to be imported, the importation of the raw and the finished product respectively depending upon the incidence of the duty, as changed from time to time. Formerly the one American manufacturer, Roessler & Hasslacher, made cyanide on a scale nearly proportioned to the consumption in the United States, but their capacity to manufacture was not expanded sufficiently to keep pace with the increasing demand. This was due largely to the expectation in 1912, and before, that the tariff on cyanide would be lifted—as became a fact in 1913, when cyanide was put on the free list. Thereafter the idea of enlarging the domestic plant was set aside, it having become possible, on account of the cost of labor, to import the material more cheaply from Europe than to make it in the United States. However, even after cyanide went on the free list, the American manufactory of Roessler & Hasslacher, at Perth Amboy, continued to make some cyanide, but not much, until the conditions created by the War—the blockade of German ports—caused a scarcity; whereupon an earnest effort was made to augment the domestic output. This would have sufficed to meet the new conditions if unfortunately, last year, the Canadian government had not placed an embargo on the use of hydro-electric power generated on the Canadian side of Niagara Falls—a step taken because the firm of Roessler & Hasslacher was put on the British 'black list.' Since then the firm has hastened to enlarge its factory at Perth Amboy and to start a new plant for the manufacture of sodium in Virginia. The cyanide now in general use in the United States has sodium as a base; this used to come from Niagara Falls. Metallic sodium is used with cyanamide, which is made by fixation of atmospheric nitrogen electrically or from coke-oven and gas-oven by-products—anything that contains ammonia. Incidentally, the use of sodium sulphide for the sulphidation of oxidized copper ores, preparatory to flotation, is likely to make further demands on the sodium output of the country. It is also necessary to mention the fact that the citrus belt of southern California annually consumes 1800 tons of cyanide for the fumigation of the orange groves, to kill an insect pest, and any failure to do so would be likely to injure the orange crop for five years.

Evidently the position is serious. Some relief is promised next September or October, when the new manufactories of cyanide will begin to produce, but the shortage is already so acute as to compel the closing of many mills, treating gold and silver ores, and to cause great loss to an important industry. Our readers are urged to bring the matter to the notice of their representatives in Congress. The bill recently passed at Washington to authorize the power-plants at Niagara to draw more water from the falls, and so to facilitate the manufacture of more sodium, was hastened through pressure brought to bear by Western mine-operators. Another obvious action is to try and obtain immediate relief by persuading the Administration to secure the release of the 4000 tons of cyanide now held in Europe. As an act of war, it is reasonable for the British government to prevent the shipment from escaping, but the injury done to the German manufacturer is much less than that done to the American consumer and an arrangement could be

made whereby the purchase price was paid to, and held by, the American government until the close of the War. Immediate action is imperative.

Teachers and Wild-Cats

Somebody has sent us a copy of *The Arizona Teacher,* a magazine published by the Arizona State Teachers Association and circulating therefore chiefly among those that instruct the young idea how to shoot otherwise than with a 'gun.' In this magazine we find an article on 'Mining Investments,' written by Mr. G. M. Butler, Dean of the School of Mines in the University of Arizona. The circumstances provoke our interest. Here is a professor of mining giving advice to people whom we, for instance, do not reach, and yet they are just the kind of seriously minded people that are likely to be drawn by the lure of the wild-cat. Of course, the word 'investments' in the title is used in the ordinary and incorrect sense. Mr. Butler speaks of advertisements offering cheap mining stock and of those "tempted to invest hard-earned savings in such ventures." The word 'invest' is wholly out of place in such a context unless we assume that the intent governs the meaning of the term and that if a school-teacher puts $100 into one of George Graham Rice's humbugs, believing it to be gilt-edged, it becomes an 'investment' to him—to the school-teacher. To Rice, of course, it is an 'investment.' However, Mr. Butler does not proceed far with his admonitions before he also discriminates between 'speculation' and 'investment,' the gist of his useful advice being the need for distinguishing between the use of spare cash in a mining speculation and the risking of a worker's wages in a gamble. As he says, it is well to distrust anyone that offers an "absolutely safe investment" in mining stocks. In times of boom the old phrases re-appear like the rubbish that a big storm flings high on the beach. The use of such terms as 'manufacturing proposition,' 'industrial enterprise,' 'gilt-edged investment,' and the like, when applied to a prospective mine, commonly indicates either the intention to swindle or else gross ignorance, for those that know anything about mining know well enough that risk is essential to a business in which great gain is promised—and often won. Mr. Butler tells the teacher that the purchase of mining stock about which he knows nothing may enable him, "to make more money than from years of work," but he warns him that he must have his eyes open and realize the essential risk—in short, he might as well put his money on the red or black, on the little horses, or on the turn of a card. School-teachers are not supposed to do that, because those addicted to such excitements are unfit for the serious work of instructing youth. However, on another page of the same magazine we find an advertisement offering stock in the Arizona Ray, and an appeal is made expressly to the dominies, for it is stated that "a certain teacher in Prescott has cleaned up enough money on Little Daisy to take his family and has been studying a year at Columbia University in New York. Another teacher in Jerome has cleaned up about $30,000.00 this year in copper stocks and is getting an income of about $300.00 per month. We know of dozens of cases of a similar nature." This is signed—by whom would you suppose—by the "Editor." At the bottom of the page it is written: "Support the Advertisers Who Support Us." Here's a pretty kettle of fish! Who is the 'Editor'? He wields English clumsily, if one is to judge from the first sentence in the note and he employs ciphers recklessly, for the .00 after the two sums mentioned serves only to magnify the amount deceptively. Is this 'Editor' the editor of *The Arizona Teacher?* If he is, then his diction is as faulty as his judgment, for the sensible article by Mr. Butler on one page does not harmonize with the flamboyant advertisement of a 'wild-cat' on another page. Whether this particular 'wild-cat' be a comparatively domesticated specimen of the genus or a fierce and bewhiskered member of an omnivorous—not carnivorous—tribe, we do not know. The quotation reproduced from a report by an E. M. is not convincing, to put it mildly, for the kind of orebodies exploited in the Ray district cannot be described correctly as "ore beds" and the contiguity to the Ray Consolidated mine is an argument that an experienced mining engineer would be slow to use, having regard to the fact that all this outlying ground must have been carefully valued by the neighboring companies. It may be a reasonable risk and a sensible venture, but it is exactly the sort of thing that Mr. Butler warns the teachers not to touch except as a straight gamble. "Buy Arizona Ray at 30c. per share before big advance" says the advertisement. Nothing is said about the capitalization; 30c. may represent a valuation for this prospect that even the finding of rich ore will not justify. The 'editor' would be better employed in ascertaining and explaining such essential items of information than in retailing stories about venturesome teachers who played a game that they did not understand. The advertisers of Arizona Ray ought to have taken care to ensure that their efforts to reach the pockets of the school-teachers were not marred by the coincident publication of such a warning as Mr. Butler's. Returning to that article, we find that he advises his readers not to consider any property "unless a competent mining engineer has reported favorably upon it." Again he makes a mistaken use of the term "small investor," meaning petty speculator. He refers to reports by pseudo-engineers, who write about "dikes of limestone" and "flows of chert." But school-teachers are unlikely to know a good report from a bad one, so he gives the excellent advice that teachers should ask a mining engineer to pass upon the prospectus or report before they make a purchase of stock. That advice is good for others besides school-teachers. It is remarkable how rarely the public avails itself of this simple precaution. The advice may well be taken by bankers and merchants also, many of whom will use large sums of money without even taking this preliminary measure of caution. As a conclusion to his remarks Mr. Butler suggests that the teachers should either grubstake prospectors or form

a small syndicate to acquire promising prospects. He suggests subscriptions of $25 to $50 per month as sufficient for the purpose and refers to a small group of Missouri Valley teachers that cleared $200,000 in a few years at a cost of $10 per month and to a group of Denver lawyers that "made millions in this way through operations in Creede and Cripple Creek." The lawyers can take care of themselves, but the teachers cannot. We fear that the article, which starts by warning simple-minded and earnest persons against wild-cats, ends by advising them to go 'wild-catting,' using this term in its less opprobrious sense of a risky venture in undeveloped claims. We can write an article on the participation of school-teachers in mining speculation in one word: Don't.

The Miami Appeal

On another page we reproduce part of the brief for the Miami Copper Company before the U. S. Circuit Court of Appeals at Philadelphia against the judgment given in favor of Minerals Separation Ltd. by the District Court of Delaware on September 30, 1916. It will be seen, as we anticipated, that counsel uses the Supreme Court's decision in the Hyde case as an argument against the charge that the process of patent 835,120 is being infringed by the Miami. The Supreme Court's severe definition of the so-called agitation-froth process of Minerals Separation enables counsel to show that the pneumatic or Callow method is of a different kind. Beyond economy in the use of oil, as practised by every millman, there is not much in common. And in regard to the so-called critical proportion of oil—less than 1%—we repeat here that the supposition of Minerals Separation that more than 1% of oil prevented flotation was based upon experiments on Broken Hill ore with the use of a heavy oil—oleic acid. If too much of that particular oil—not now used in the United States—was employed, it tended to coagulate the metallic particles into granules, which sank to the bottom of the cell, spoiling the operation. Again, the particularly coherent, persistent, and otherwise remarkable froth, to which the Minerals Separation people made claim, was due undoubtedly to the thick kind of oil that they used as a modifying agent. We know now that the character and quantity of the froth are readily affected by the choice of the contaminant that lowers the surface tension of the water so as to make the bubbles sufficiently long-lived to perform their metallurgic function of buoying the mineral particles and carrying them over the lip of the flotation-cell. Agitation also is a factor, insofar as it determines the quantity of air admitted into the pulp and the degree of emulsification. The Supreme Court decision lays stress on the proportion of oil, the stability of the froth, and the character of the agitation, no one of which, we believe, is essential to the success of the flotation process generally, however necessary to the method described in patent 835,120.

Another interesting feature of the brief is the discussion of the soluble frothing agent of patent No. 962,678. It will be remembered that the lower court decided that Miami had infringed this patent also, by reason of using cresol with pine-oil. During the trial of the case it was acknowledged by Minerals Separation that the methods described in 835,120 and 962,678 were alike; it was also conceded that the claims of both patents call for vigorous agitation, which the Supreme Court has interpreted to mean such agitation as will beat the necessary air into the pulp. It is argued now that the use of tar and tar-products as specified in No. 793,808, the perforated-coil patent, invalidates No. 962,678. Moreover, it is a matter of record that Haynes, in his patent of 1860, mentions the use of coal-tar from gas-works and refers separately to insoluble substances such as "oleaginous matters." Coal-tar is soluble to the extent of about 20%, and indeed all the flotation-oils are variously soluble. The grant of a patent for a soluble frothing-agent shows to what an absurdity patents can be reduced. Cattermole, Sulman, and Picard described the use of phenol and cresol, two soluble agents, in patent No. 788,247. Neither in that patent nor in 962,678 is the proportion of the frothing agent specified, and it has been admitted by the Minerals Separation experts that any amount of the soluble modifying agent is effective to produce the desired result. In the light of the Supreme Court's decision on patent 835,120 and the emphasis placed therein upon a 'critical' proportion of oil, it may be that the vagueness of patent 962,678 will prove a final bar to validity. We hope it may, for immunity from patent monopoly will stimulate the many efforts now being made to use modifying agents other than oil and to develop the flotation process to further efficiency. If any one company, particularly the one that has tried persistently to prevent the spread of technical information on the subject, is to control productive research, it is unlikely that fruitful investigations will be multiplied. The flotation process is the product of the work done by a hundred men, not two or three industrious patentees. Any accurate apportioning of credit and of reward is impracticable, and it remains for all to do their work in the scientific spirit, which aims to achieve results, not to tax the application of them.

The Minerals Separation people are following the bad example of the cyanide patentees, in standing astride the mining industry with a club. Those who recall the first applications of cyanidation on the Rand will remember that the principal mining companies, led by the management of the Robinson mine, were ready to pay something like 2½% royalty on the gold extracted by cyanidation, but the patentees wanted 7%. Against this exaction the mining companies decided to fight, and they fought successfully, so that the South African mines never paid any tax on the use of the cyanide process.

By the way, we shall be glad to give equal space and publicity to the brief of Minerals Separation in the appeal at Philadelphia if a copy of the text is sent to us either by the company or by one of its friends.

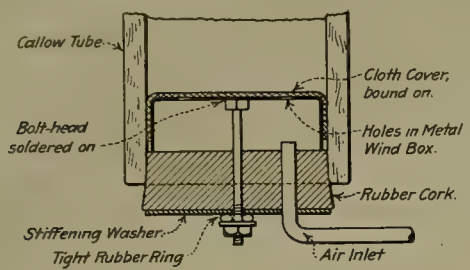
DISCUSSION

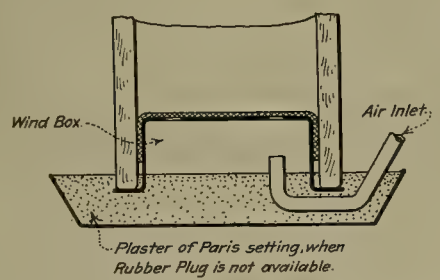
Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

A Flotation Testing-Machine

The Editor:

Sir—You showed an illustration of a Callow testing-cylinder in an article some time ago. I enclose a sketch





of a method I have used for making the bottom of such a cylinder.

ALFRED T. FRY.

Broken Hill, N. S. W., November 25.

The Prevention of Misfires

The Editor:

Sir—The kindly criticism on my recent article by Mr. Edward Higgins and Mr. W. S. Weeks is duly appreciated. As I differ somewhat from the above gentlemen, and to some extent with the quotations cited by them from U. S. Bureau of Mines, also as one or two of my suggestions seem to have been misunderstood, I deem it only proper to make my position clear, prefacing my remarks by saying that the suggestions in this and my original article are based upon close observation and practical experience covering many years, and at many times having a direct financial interest in the results obtained from the use of explosives. As to the danger of a misfire through bending of fuse, as Mr. Higgins says, more than 40°, or in any event over 180°, as is the case in the method mentioned, it would seem that the diameter of the bend should be taken into consideration, as it is bent 360° in the original coil without injury, and with good fuse, in proper condition, it may be tied in knots, and will not crack or miss.

The method I prefer in making primers is to punch a diagonal hole in the powder near the end of the cartridge, insert the cap, and bend the fuse across the end of the powder, and insert in the hole, cap-end first. This leaves a chance to press the powder firmly into the drill-hole without disturbing the cap. While a wooden punch is desirable, and should be employed, it is seldom that it is used, it being an almost universal custom to use the pointed end of a candlestick for the purpose and while this looks careless, I do not remember ever having heard of an accident from this cause.

As to tying paper around the fuse with a string, as suggested, it is quite likely that in most instances it would be neglected, though quite necessary, if primers are to be made in the manner suggested by Mr. Higgins. When made after my method there is no need of tying. Another advantage of this method is that when loading 'uppers,' as in a raise or stope, the powder may be pressed firmly, so as to fill the hole, thus holding it in place. Another stick of powder is placed on top of the primer and pressed so as to fill the hole, completing the operation. As to the use of tamping in 'uppers,' even if it were desirable, it is generally out of the question, as there is seldom at hand any suitable material for the purpose, although sometimes a small piece of wet burlap is used to assist in keeping the powder in the hole.

As to Mr. Weeks's suggestion that in case sufficient resistance were offered by the air, 'bulldozing' would be a most efficient method, I submit that under the conditions to which this method of blasting is adapted, it is quite efficient. I can hardly believe Mr. Weeks would suggest bulldozing in the face of a drift, when the rock had no chance to break, except toward the powder. This method is quite efficient when applied to detached rock, or boulders, and its efficiency is due to the resistance offered by the air to the explosion. It requires the use of more powder than when holes are drilled, for the reason that the energy of the powder is exerted against the rock in one direction only, whereas when confined in a hole its force is exerted in all directions.

In this method there is generally much more powder used than is required. I have seen men on construction work, and on highways, etc., in order to remove a stump, dig a hole under it and then use a 50-lb. box of powder. Needless to say, the stump was removed. It is also true that less than one-fourth the amount of powder would have accomplished the same result.

In the quotation from the Bureau of Mines publication, while stating that the use of the most efficient stemming materials may increase the useful energy of the shot 93%, it is not stated that this refers to nitro-explosives, though such is inferred. If so, it is quite contrary to my experience; anyway, it is likely that the experiments were conducted under conditions quite different from those encountered in actual mining practice, and even though the useful energy should be somewhat increased, this advantage would be more than offset by the chance of having a miss from causes I have mentioned.

Lastly, contrary to Mr. Weeks's impression, I do not favor placing the primer in the bottom of the hole, neither do I place it in the top, but, as stated, in the second stick from the top and cap-end *down*, as it is not desirable to have the cap too near the collar of the hole, thus increasing the chances of its being pulled out by tearing away of a portion of the hole by another shot, or of the fuse being caught by a flying piece of rock.

As to misfires being caused by bending the fuse while cold, or using damp fuse, this is readily admitted, though the blame for using damp fuse is on the management for not having it stored in a suitable place. A miner has no choice but to use what is furnished him.

E. F. Brooks.

El Dorado, California, January 10.

The Editor:

Sir—Just an additional word on this important subject. I have found that there is a decided advantage in placing cartridges of nitro-powder in drill-holes if the paper envelope be slit in two or three places with a knife longitudinally of the cartridge before inserting it in the hole. This permits the soft yielding powder to spread out, completely filling the cross-section of the hole when the charge is pressed firmly forward with the tamping stick—not the iron spoon—and the powder then remains where it has been placed. This scheme is particularly useful in charging 'uppers.' In some mines suitable material for tamping is not easily available underground, and miners usually take a can or box of loam, or clay, or some sort of earth, into the mine with them to be used in tamping holes, and particularly uppers. I note what Mr. E. F. Brooks has said concerning the charging of holes without tamping, and while I agree with him that tamping is not of vital importance, yet miners have become so accustomed to tamping all holes, that many of them look upon charging a hole without tamping as a foolish waste of time and material; so tamping will probably continue to be the fashion for some time to come.

Bulldozing is resorted to, both on the surface and underground, to break large boulders, and is generally done by sensible miners without any cover whatever, unless it be just enough soft dirt packed around the powder to keep it from rolling off the rock from a gust of wind, or from the concussion of another shot near-by, but of all the foolish and dangerous practices to which many miners resort the worst is that of piling on the powder a lot of small rocks, from fine stuff to pieces as big as a man's first. When this is done the rocks fly in all directions and no one within a quarter of a mile is safe. I have knowledge of one instance where the manager of a large mine was hit on the leg by a piece of rock flying from a bulldozing shot, fired in a glory-hole, and that had been fixed in this insane manner. He was fully 600 ft. away at the time. He never completely recovered from the injury, and yet, the practice of covering bulldozing shots with loose rock continued at that mine.

Miner.

Barstow, California, January 20.

Effects of Faults

The Editor:

Sir—In the discussion columns of your issue of December 23, 1916, under the heading 'Effects of Faults on Richness of Ore,' Enquirer observes that in most instances under his notice where a vein or orebody is intersected by a fault, the continuation of the ore beneath the plane of dislocation is of lower value than that above the fault.

This is a condition which I have often observed, especially in veins carrying copper, gold, or silver. While it is dangerous to generalize too broadly in mining geology, I am convinced that in most of the deposits of this nature which I have studied the explanation lies in the fact that above the fault intersection the ore in the veins has undergone secondary enrichment by cold descending solutions. The mineral-bearing solutions upon encountering the fault would be diverted from the vein to the fault-zone, which is often more permeable than the vein itself. Thus, the process of secondary enrichment is confined to that portion of the vein above its intersection with the fault. This conclusion is supported by the frequent existence of sulphides and oxidized minerals above the fault, below which the ore changes abruptly in character, and consists of the primary minerals. I have observed this most commonly in copper deposits, but secondary enrichment also plays an important part in gold, silver, and zinc deposits. Galena veins are seldom enriched to any marked degree, most of the galena being primary.

The decided enrichment in the vein or orebody just above the fault-plane, noted by your correspondent, is a phenomenon which, I think, many of us have observed, and it may be explained by the fact that such an intersection of two fissures is an especially favorable place for ore deposition. The descending solutions from the upper part of the vein may be 'ponded' there temporarily, and in copper, gold, and silver deposits exceptional enrichment may result at such places. Moreover, these descending solutions may encounter other solutions ascending along the fault-zone, and precipitation of rich ore minerals may result.

Often secondary minerals are found in the portion of the vein below the fault intersection, but generally in smaller amount than above. In such cases they have usually been introduced before faulting occurred, and subsequent enrichment would be confined to the upper

portion of the vein above the fault. On the other hand, the existence of a fault across the vein does not necessarily imply a decrease in the value of the ore below the fault intersection, for it is not unusual for the value of the ore to continue unchanged, especially if conditions are unfavorable to secondary enrichment.

Every mine has its own peculiar geological problems, and I would not infer that the above explanation will cover every case, but I believe it will apply in many instances under the conditions stated.

E. K. Soper.

Moscow, Idaho, January 10.

Some Pertinent Questions

The Editor:

Sir—In your issue of January 13 I notice a list of important questions under the heading of 'Some Pertinent Questions.' I must agree with the author that few superintendents can answer these questions off-hand, even in regard to the mine they are operating.

It is impossible to answer the first three questions without first taking into consideration the kind of rock you have to deal with. I have been in some mines where the rock varied to such a marked degree that what was considered a good shift's work in one place would not be considered so in another. I have in mind some of the mines in the Cripple Creek district and also in Leadville. The same will also apply to some of the mines on the Mother Lode here in California. There are places in the same mine where a good man working single-handed would not drill over four feet in an eight-hour shift, while in other places in the same mine a miner could drill nine to twelve feet and more, in the same time.

Answering the fourth question, it depends upon whether the rock breaks fine or coarse, for when it breaks moderately coarse and has sharp corners that catch and hang to the shovel, it is much slower to shovel than where it breaks fine. In shoveling from a rocky bottom, all one can use is the round-pointed shovel, whereas, if from a properly placed wooden plat, and very few of them are so placed, the shoveler can use a mine-scoop. I have found that while the steel plat costs more to install, it is by far the cheapest in the long run.

I should say that the steel plat with the square-pointed mine-scoop is 100% ahead of the rock-floor and the pointed shovel.

The seventh question cannot be answered without taking into consideration the nature of the ground through which you are driving. In many cases it is perfectly safe to drive 20 ft. or more ahead of the last set, while I have been in ground where I had a hard time holding it with 4-ft. sets and driving the lagging ahead. This is a question that has to be determined as the work progresses.

As to the best angle on which to drive an incline that is to be used to pass ore by gravity, my experience has shown me that the angle varies with the kind of rock. One ore will pass safely over one angle that will be either too flat or too steep for another ore. This is also a question that has to be determined by actual experiment, on the ground.

As to the number of cubic feet of quartz in place required to weigh a ton, this will depend to a certain degree upon how well it is mineralized and also the amount of moisture in it. Some quartz it is safe to allow 17 ft. when broken, and others not over 13 or 14 feet.

I do not think any man should be required to spend over eight hours working underground. I have been in mines that worked eight hours and also those that worked ten hours, and my experience has shown me that the miners will do about as much in eight as they will in ten. I have found that the man that did not do a good shift's work in eight hours, did not do so in ten. I have found that a good miner is more efficient, month in and month out, if he works eight hours than he is if he has to work ten.

The bonus system is good for some kinds of work, such as drilling and shoveling. One has first to determine what a good shift's work is, then use that as a basis to work from, giving a bonus for all over that, as it acts as an incentive for the men to work harder and more intelligently, therefore accomplishing more at very little added expense.

I am not at all in favor of the contract system in any kind of mining, as I find that with efficient management, the men can be made to do just as much work on company time. There is a system in vogue in many mines of contracting the development work and I cannot see the economy of it when they keep the shift-bosses, foreman, and superintendent to look after the company work. If the contractor can get more out of his men, then I should be in favor of making him either foreman or superintendent of the mine and save the company's money. I have found that by far the greater part of the contractors have to be watched closely or they will slight the work in their favor, and it takes no more time to attend to the work on company time than it does to watch the contractors.

Arthur W. Stevens.

Piedmont, California, January 15.

The Editor:

Sir—I have carefully studied the A B C questions stated in your issue of January 13, and am forced to admit that I pass—or rather—fail. I might have been able to answer some of them when I used to sign my name with the E.M. attachment, but I have even forgotten now whether I ever could have answered most of them. If you continue the list, please stop along about L M N, because there will surely be considerable embarrassment felt throughout the profession by that time—and as for the X Y Z, there would be no one left in the class, except possibly a few mining professors.

It may be that there are two classes of superintendents, one with hats larger and the other with hats smaller than 7. So that there may be hope for the majority; let me state that mine is under. The lack of available room may explain my ignorance, but it has always seemed to

me that the mind which contained numerous figures and other data was not a mind capable of invention or originality in meeting the numerous emergency problems that confront the mine superintendent, especially of a small property. "Necessity is the mother of invention"; therefore the man who doesn't have the figures in his head is under the necessity to produce the invention; and the constant exercise of invention, even in small ways, must develop greater originality. The result is that each problem is met by a solution which is especially applicable to it, and while an extra amount of time may be consumed in doing it, the ultimate efficiency more than compensates. In organizing a new mining property, in opening up a new stope, or in breaking-in green men, there is no benefit in knowing the costs attained elsewhere; the problem rather is to cut and fit the available forces to suit the unchangeable conditions. The best possible results in any particular case may be far below or perhaps far above the average recorded results elsewhere. Even after everything has apparently been considered and figured out, there will be frequent changes necessary, or else the whole system will revert to chaos. I would like to hear from some of the 'above 7's' as to whether they consider that their originality and invention is impaired by carrying around an unlimited number of facts and figures.

ALFRED STRONG LEWIS.

Phoenix, Arizona, January 15.

Chinese Antimony

The Editor:

Sir—It may interest you to know the conditions affecting the antimony market in China, which is, as you know, the chief source of supply for the world.

The sensational fall in the price of antimony which took place on the New York market during the summer months of this year and which was due to causes that I need not mention here, has had as an immediate effect the curtailing of the mining output, as well as of the smelting capacities of the works of the chief producers in China. This was followed by the gradual shutting-down of a great many small mines that were hastily opened up at the time of the boom in price, and the small smelting works that depended on the supply from such mines have naturally had to suspend operations. Moreover, the tremendous speculations that took place among the Chinese merchants have caused them tremendous losses and reduced some of them from a prospective millionaire condition to a state of bankruptcy. Of course, the large producers have been able to stand the test, for the reason that they have accumulated large profits and depend mostly for the supply of raw material on their own mines.

The situation at present seems, in my opinion, to have undergone a decided change for the better. In the first place the large stocks that existed during the early summer months in Shanghai, Hankow, and Changsha have gradually disappeared and so far as I know have not been replenished. Some of the Chinese speculators have dropped out of the market entirely, either on account of having losses or through the difficulty in getting the metal from the small sources that sprang up during the time of the boom in price.

Looking to the present position, we have to reckon with two important factors that exercise a very strong effect on the antimony prices likely to rule for some time to come:

In the first place, there is a tremendous rise in freight both to Europe and America. Prior to the War the freight on antimony from China to New York was only 25s. per ton, whereas at the present time the freight is 90s. per ton, with every prospect of it being raised again as the shipping conditions become more and more acute.

In addition to this there is a tremendous war-risk premium on shipments from the Far East that was practically eliminated prior to the War.

In the second place, we have to reckon, and to a very great extent, with the abnormal rise in the price of silver. This rise, which is almost unprecedented, has already seriously affected exports from China and commodities that are unable to secure a higher price through competition from other quarters are lying idle in the godowns of Shanghai.

The Chinese smelter reckons his profit in Chinese currency, that is, in taels, and if the exchange for remitting money from abroad to China is unfavorable, he is bound to raise the price for his commodity, otherwise he might make a dead loss on the transaction.

It is evident, that the natural consequence of the above-mentioned factors is to crystallize itself into a rise of the price of antimony and I am inclined to believe that all the time that these factors exist and are likely to continue, we are going to see, if not higher limits, at least a continuation for some time to come of those prevailing at the present moment.

Of course, it cannot be overlooked that buyers take the view, on account of the peace rumors, that prices are likely to be adversely affected, but it does not seem to me that—considering the present stocks—this will be the case, whereas the possibility of a return to pre-war prices, while the conditions mentioned continue to prevail, does not appear probable.

It must also not be overlooked that there is a marked falling off in the Bolivian ore shipments, which have been unable to stand the stress of the falling prices, demonstrating once more the preponderating position of the Chinese mines.

K. C. LI.

New York, January 10.

GOVERNMENT MILLS are operated in Western Australia, South Australia, and Victoria. These treat gold and tin ores. Queensland has recently started its first public mill. This is at Bamford, about 25 miles inland from Cairns on the coast of the northern part of the State. The five 1000-lb. stamps, tables, jigs, and vanners will treat wolfram ore, also tin ore from small mine-owners. The plant is well situated for this work.

THE BUNKER HILL SMELTER IN PROCESS OF CONSTRUCTION.

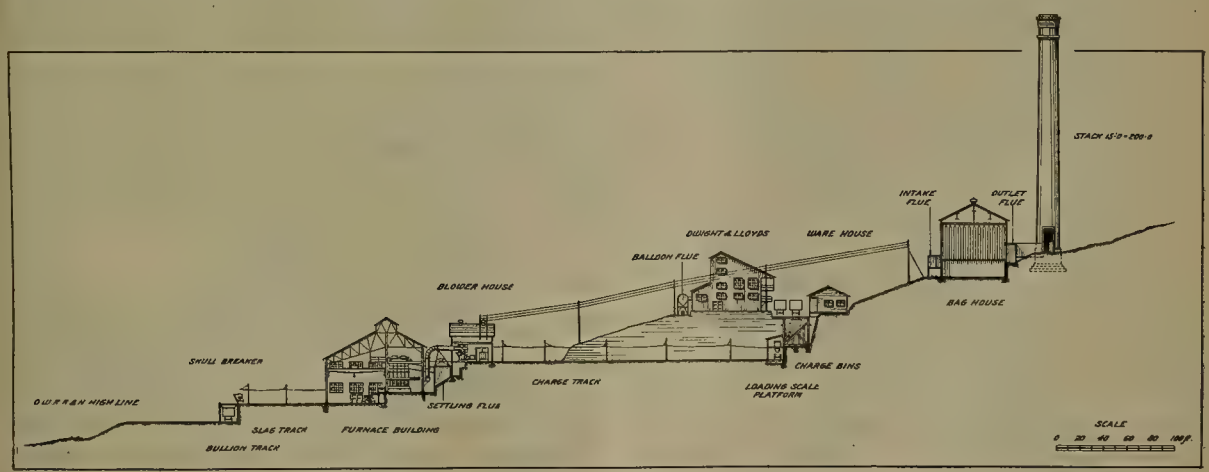
The Bunker Hill Smelter

By Jules Labarthe

The site of the new Bunker Hill smelter and refinery is near Kellogg, in Idaho. The plant consists of a complete equipment for the sampling, roasting, sintering, smelting, and refining of gold, silver, and lead ores. The buildings will cover an area of 30 acres, and the equipment will consist of the following:

Sampling-Mill. The ore and concentrate will be received in standard-gauge railroad-cars and delivered to receiving-bins, from which the material will be removed by belt-conveyors to the crushing and sampling department. This department will have a capacity of 50 tons of ore per hour and will be equipped with a 10 by 20-in. Blake crusher, two sets of 36 by 14-in. rolls, also a set of 12 by 12 rolls, a 48 by 72-in. trommel, and four Vezin samplers. After crushing and sampling the material will be transferred by belt-conveyors to any one of eight large storage-bins. Each of these bins is provided with two apron-belt feeders by which the correct proportion from the bin can be fed to the belt-conveyor and delivered to the roasting-department.

Roasting-Department. The roaster-building is of steel construction, 112 by 57 ft. in plan, and contains four 42-in. standard Dwight & Lloyd machines. These machines are to serve as a desulphurizing and sintering equipment. In addition to the Dwight & Lloyd machines there will be one multiple-deck Wedge roaster. This furnace will be used to give a pre-roast to lead matte or material carrying a high percentage of sulphur. The product of the Wedge furnace will be mixed afterward with the regular D. & L. charge for the purpose of further desulphurizing and sintering. The estimated capacity of each D. & L. machine is 100 tons per day. The capacity of the Wedge furnace is 50 tons per day. These furnaces are equipped with large storage-hoppers, which are filled by means of a belt-conveyor system that delivers the ore from the storage-bins. The sintered ma-



SECTIONAL ELEVATION OF BUNKER HILL SMELTER.

terial will fall from the D. & L. machines into standard-gauge hopper-bottom steel cars unloading into concrete storage-bins.

Charge-Bins. The blast-furnace will be fed from 24 bins of 3400 cu. ft. capacity each, divided as follows: eight bins for roasted and sintered material—these bins are constructed of reinforced concrete; eight bins of timber construction to be used for limestone, crude ore, slag, by-products, etc.; and eight timber bins for coke.

Each bin has two discharge-openings provided with arc-gates. Under each opening there is a four-ton capacity hopper-scale. The charge is accurately weighed from the bin to the hopper and held in the hoppers until delivered to the blast-furnace charge-cars. The hoppers and discharge-doors are so constructed that the material is delivered to the charge-car in a layer so that a bedding effect is obtained in the car itself.

In addition to the storage of approximately 400 tons of coke in the charge-bins there is a large coke-storage provided in the rear of the charge-bins where approximately 3000 tons of coke can be held and delivered from the storage to the charge-bins by means of a locomotive crane and clam-shell bucket.

Blast-Furnace Department. This building is of steel construction, 80 by 126 ft. The charges are conveyed in standard-gauge hopper-bottom special-design steel charge-cars from the charge-bins to the blast-furnace building. These cars are handled by four-ton electric locomotives. The cars discharge directly into the blast-furnaces. The charge-floor of the blast-furnaces is level with the bottom of the charge-bins.

The three steel-jacketed blast-furnaces are 42 by 180 in. at the tuyeres. The height of the furnaces from the centre of the tuyeres to the feed-floor is 20 ft. 9 in. Each furnace is provided with twenty 4-in. tuyeres. The estimated capacity of each furnace is 200 tons of ore per day. These furnaces are arranged with under-floor down-takes.

The furnace-building is provided with a 20-ton 4-motor traveling crane that serves the blast-furnaces and the refinery. The blast-furnace receivers or forehearths are made of cast-steel with trunnions, and can be lifted and changed by means of the electric crane.

The bullion will be delivered from the blast-furnaces to lead-pots. These pots in turn will be handled by the crane directly to the refining-department, which is under the same general roof as the blast-furnaces.

Lead Refinery. This building is an extension, 105 by 108 ft., of the steel blast-furnace building, and is served by the 20-ton crane, which also operates above the softening-furnace and desilverizing-kettles. There have been provided two 80-ton softening-furnaces and four 50-ton desilverizing-kettles. At an elevation of 10 ft. below this equipment there are two 80-ton refining-furnaces and four 50-ton merchant-kettles, namely those in which the refined lead is accumulated prior to casting in merchantable form.

The molten lead is removed by means of centrifugal pumps from the merchant-kettles to the moulding-machines, which will be of the type designed by John F. Miller at Trail, B. C. These machines each have a capacity of approximately 15 tons of pig-lead per hour.

Silver Refinery. This building will be of brick construction, 60 by 82 ft., and contain eight large Faber du Faur furnaces, two cupelling-furnaces, one fine-silver furnace and a complete equipment for parting and precipitating silver. There will be crucible-furnaces for melting gold. The copper used in the precipitation of silver will be recovered in the form of copper sulphate. A complete plant for the crystallization of copper sulphate will be contained in a frame building adjoining the silver refinery.

Power Plant. The power-house is steel and brick construction, 35 by 40 ft. The electric power will be supplied by the Washington Water Power & Light Co. at a 2200-volt potential and the larger motors of the plant will be operated at that voltage.

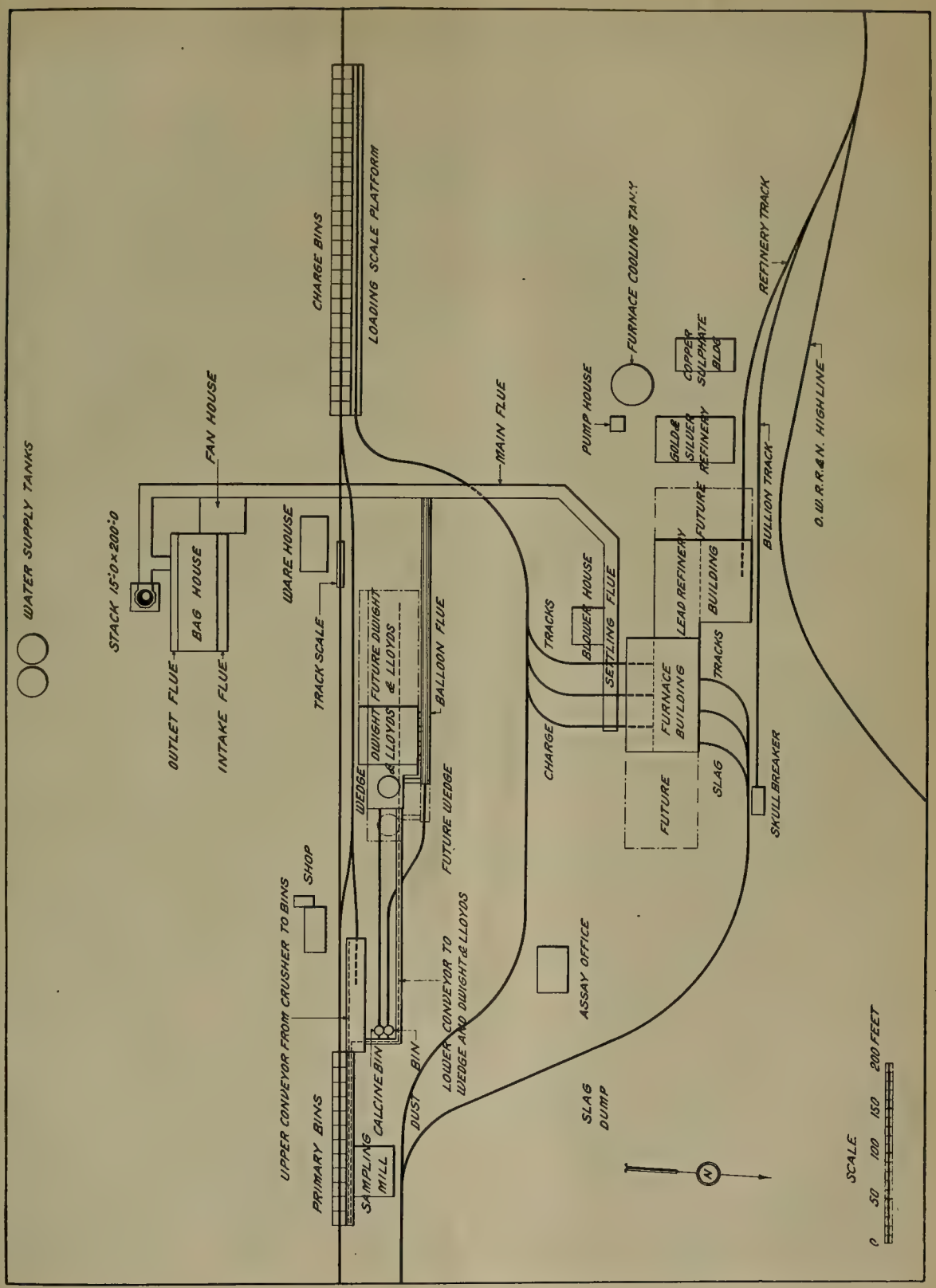
There are two Ingersoll-Rand turbo-blowers each with a capacity of 12,000 cu. ft. of air per minute at 48-oz. pressure. These blowers will be geared to two General Electric 200-hp. induction-motors. In addition, two 75-kw. motor-generator sets are provided, one to serve as an auxiliary unit. These sets are to supply direct current for trolley-locomotives and electric cranes.

Fume Treatment. The blast-furnace gases will be delivered to a bag-house through 600 ft. of brick dust-chamber. The bag-house is of brick and steel construction, 56 by 130 ft.; it is divided into three separate chambers above the thimble-floor. Each chamber contains 400 bags, or a total of 1200 bags. Below the thimble-floor there are 12 divisions to facilitate the removal of the collected fume. There have been provided two electrically driven fans of 60,000-cu. ft. capacity each, one fan to be held in reserve.

The gases from the Dwight Lloyd sintering-machines and Wedge roasting-furnaces are delivered through 400 ft. of steel balloon-flue to Cottrell tubes. The Cottrell apparatus has a capacity of 60,000 cu. ft. of gas per minute. The building is entirely of steel. All the gases, after passing through the bag-house and Cottrell tubes, are delivered to a Custodis brick chimney of 15-ft. internal diam., 200 ft. high.

General Equipment. The plant will be complete, with brick assay-office and laboratory building, 46 by 46 ft., warehouse, machine-shop, dry-house, and office. There will also be a high-pressure fire-system, complete electrical system, and sewerage.

Coal miners in Australia are apparently always making fresh demands on their employers. During November last the collieries were idle at Newcastle and other districts on account of the men demanding that their 8 hours should include from 'bank to bank,' that is, that work commence and end at the shaft collar. The strike was declared off when the board appointed to deal with the dispute ordered a resumption of work by conceding the men's demands.


WATER SUPPLY TANKS
STACK 15'-0"×200'-0"
FAN HOUSE
BAG HOUSE
OUTLET FLUE
INTAKE FLUE
WARE HOUSE
TRACK SCALE
CHARGE BINS
LOADING SCALE PLATFORM
MAIN FLUE
PUMP HOUSE
FURNACE COOLING TANK
COPPER SULPHATE BLDG
GOLD & SILVER REFINERY
REFINERY TRACK
BULLION TRACK
O.W.R.R.&N. HIGH LINE
FUTURE
LEAD REFINERY
BUILDING
FURNACE BUILDING
BLOWER HOUSE
SETTLING FLUE
BALLOON FLUE
FUTURE DWIGHT & LLOYDS
DWIGHT & LLOYDS
WEDGE
FUTURE WEDGE
TRACKS
CHARGE
SLAG
SKULL BREAKER
SHOP
UPPER CONVEYOR FROM CRUSHER TO BINS
PRIMARY BINS
SAMPLING MILL
CALCINE BIN
DUST BIN
LOWER CONVEYOR TO WEDGE AND DWIGHT & LLOYDS
ASSAY OFFICE
SLAG DUMP
N
SCALE
0 50 100 150 200 FEET

Treatment of Manganese-Silver Ore

By Walter Neal

*Prior to the revolution in Mexico considerable interest was taken in the problem of treating the manganese-silver ore of the El Favor mine, in the Hostotipaquillo district, Jalisco. Since April 1914 the mine has been idle, but experiments have been continued in the United States by Mr. Neal and others. While the work is not complete, the progress detailed in this article is well worthy of record.

The insolubility in cyanide of the silver in several ores where it is accompanied by manganese oxides is well known. The problem is complicated by the fact that the exact nature of the rebellious mineral is not known—whether there is a definite chemical combination of the manganese and silver, or whether the manganese functions as an insoluble coating over the silver mineral is not yet established. Not all silver ores carrying manganese oxides are rebellious, and not all the silver in a given rebellious ore is insoluble. Generally, in an ore from a given orebody a definite amount of the silver is soluble and the rest quite insoluble. Furthermore, the ratio of soluble to insoluble silver does not vary with the manganese-content of the ore, nor does the total silver-content vary with the manganese-content. Only the manganese occurring as oxide interferes with the solubility of the silver in the ore, and silver occurring with rhodonite or rhodochrosite is usually quite soluble. For this reason it has been usual, where trouble with extractions has been traced to the presence of manganese, to seek more docile ore in depth, leaving the oxidized ore to be treated at some future date.

The El Favor lode is an almost vertical vein of quartz in andesite. The ore is highly silicious and darkened by manganese oxides. An analysis of a representative sample shows:

	%		%
Manganese	3.49	Copper	Trace
Sulphur	0.67	Silver, ounces per ton	.20
Iron	0.70	Gold, ounces per ton	0.075
Calcium	0.42		

Manganese is present in the form of oxide in the upper levels of the mine, although rhodonite and rhodochrosite also appear on the lower levels. Iron is present both as pyrite and as oxide. Silver in the higher-grade ore is often observed as a chloride, but direct observation of its rebellious form in the ore under discussion is lacking. A trace of copper appears in the concentrate, but the amount is so small that it is not found by assays of the ore. Gold generally occurs in a ratio of 3 : 1000 of silver. The gold is readily soluble in cyanide, and extractions of over 90% are consistently obtained in the mill. The ore yields to milling 10% of its silver as a concentrate, assaying from 100 to 150 oz. per ton, and 40 to 45% as bullion from the cyanide plant.

F. B. Laney, microscopist of the U. S. Bureau of Mines' Experiment Station at Salt Lake City, considers that the predominating silver mineral both in the high-grade flotation concentrate and in the gravity concentrate from the same is proustite. It reacts for silver and arsenic. Bismuth and antimony are absent. Galena, sphalerite, chalcopyrite, and covellite are present in minute quantities. The manganese is present as a mixture of oxides, principally psilomelane, and possibly pyrolusite.

The first serious work done on the metallurgy of the ore was in 1911, when E. M. Hamilton was commissioned to make a study. After investigating various possible processes, he recommended the removal of the manganese by solution in sulphurous acid with cyanidation of the bleached tailing. This treatment promised an extraction of 90% of the silver, and, so far as could be determined by experiments on a laboratory scale, offered an acceptable process. In view of the expense of installing a test-plant on an adequate scale, it was decided to exhaust other possibilities first. Consequently, when Mr. Neal took charge in the following year, it was with Mr. Hamilton's excellent report before him, and with the determination to try any and every process that offered the slightest promise.

The first step in testing was to exhaust the possibilities of hydraulic concentration. Experiments made locally offered no promise along lines of wet concentration, and the vanners were finally scrapped, leaving only the Wilfleys in the concentration department. Other processes were investigated, among the first being that of the Huff Electrostatic Separator Co. Experiments were conducted at the Boston Institute of Technology under the direction of E. D. Bugbee. After preliminary tests with various processes, he recommended magnetic separation on Wetherill machines, followed by chloridizing-roasting and cyaniding of the product, and direct cyanidation of the Wetherill tailing. This process undoubtedly offered an improvement. One objection to adopting it at El Favor was that it involved dry crushing and it was hoped that a wet process could be developed that would be more easily adapted to the equipment at present installed at the mill. An elaborate series of tests was carried out by the Henry E. Wood Ore Testing Co. of Denver. After describing various tests in detail, they summarize: "The results of standard treatment by concentration and cyanidation are so thoroughly established that we consider it ill-advised to test further along those

*Abstract from *Journal* of Chem. Met. and Min. Soc. of South Africa, August, September, and October 1916.

lines. We do, however, have to advise that we tested by concentration, passing the tailing re-ground through a special bromo-cyanide treatment with no benefit." As chloridizing-roasting appeared to them to be the most promising lead, they made an elaborate series of tests, which they summarize as follows: "We conclude that you are justified in demanding a recovery by a 2% salt roast and cyaniding of 70%; plus concentration, 80.50%; and by exact chloridizing and cyanidation you should obtain 85%." The problem was next passed to the Wedge Mechanical Furnace Co. The preliminary tests indicated a volatilization of 12½% of the silver during roasting; this could probably be recovered in a scrubbing-tower, and promised an extraction of 76.7% of the silver by cyanidation following chloridizing, thus agreeing fairly well with the Denver opinion.

While on the subject of roasting, it may be mentioned that tests made by S. D. Kempton, roasting with 2% of salt and cyaniding the product for 64 hours with a 0.5% cyanide solution, gave a recovery of 82.3%, by assay of the tailing; also that work done in the laboratory of the El Favor Mining Co. confirmed the above results, and demonstrated that a short roast (less than 15 minutes) was quite sufficient for effective chloridizing. At the time the mine was abandoned, a small furnace of the Stetefeldt type was under construction to test the roasting idea on a larger scale.

In view of the tests above cited, there seems to be no doubt that an extraction of 80%, less volatilization losses, should be obtained by chloridizing-roasting followed by cyaniding. Experiments made at the El Favor mine, and checked at Salt Lake City, on reduction of the manganese by roasting in a reducing atmosphere, gave promising results. Elmer E. Carey reported an extraction of 25.6% by his process of electro-amalgamation. The Parks Electro-Cyanide Co. succeeded in extracting 40% of the silver in the form of amalgam in seven hours, with a consumption of 5.28 lb. cyanide per ton of ore. Concurrently with this work an active campaign was carried out at the mine by Mr. Neal and the mill superintendent, H. L. Wilson, both in the plant and in the laboratory. By the time-honored expedient of getting the tonnage up and the costs down and by improving the mechanics of the treatment, the business was made to show a profit, but the main problem remained unsolved, and they had to contend with a loss of 50% of the silver in the tailing.

All the work done on El Favor ore has indicated the necessity of completely decomposing the manganese in the ore before a satisfactory silver extraction can be obtained. A large number of tests were made with the result that sulphuric acid, with some chemical capable of taking up oxygen readily, proved to be the best and cheapest method of decomposing the manganese. The chemicals giving the best results were hyposulphite of soda, oxalic acid, sulphate of copper, and ferrous sulphate.

The last work done at the mine was to investigate the possibility of treating the concentrate at the mine. A process that Mr. Neal was preparing to try on a large scale consisted of saturating the concentrate with gas-oil—crude oil might have served as well—and then giving a quick roast in a covered dish in a hot muffle. Three to five minutes in a hot muffle gave the best results. After roasting, the concentrate was re-ground to pass 200-mesh and treated in the usual way with a 0.5% solution of cyanide. Three or four agitations of 10 hours each proved satisfactory, and reduced the silver-content from 136 to 13.6 oz. per ton. Wet methods of treating the concentrate were not at all satisfactory, as the concentrate contained a large amount of black residue, rich in silver, that could not be decomposed by sulphuric acid and ferrous sulphate.

John D. Fields of Maxville, Montana, proposed to treat the ore in his electro-flotation cell, and for a time great hopes were entertained of this process. Results, however, were erratic, and occasional promising extractions were offset by the part failure of confirmatory experimenting.

Continuing the work of Messrs. Hamilton and Wilson, some hundreds of tests have been made on processes involving the removal of the manganese with sulphur di-oxide. Attention was also turned to a double treatment involving the removal of the manganese with sulphur di-oxide and ferrous sulphate, with cyaniding of the bleached tailing. A feature favorable to this process, when compared with the 'hypo' process lies in the fact that the ore contains a small quantity of gold, which is soluble in cyanide, but not in 'hypo.' It became evident at this stage that after complete dissolution of the manganese all the silver was soluble in cyanide solution.

In the meantime developments in the flotation of the silver have been so encouraging as to make Mr. Neal speculate whether that did not offer a solution of the problem. During the past winter, by courtesy of the U. S. Bureau of Mines, he had the freedom of the Experiment Station at the University of Utah, as also the advice and assistance of the metallurgists of the Bureau. Flotation of the raw ore gave unpromising results. As a matter of record it may be stated that flotation was attempted in solutions of lime, cyanide, 'hypo,' caustic potash, sodium carbonate, and sulphuric acid, with coal-tar creosotes, wood-creosotes, various pine and pine-tar oils, cedar-oils and others for frothing reagents. Three lots of concentrate totaled 29.9% recovery. Cyanide treatment of the tailing extracted a further 32.4% of the silver, making a total extraction of 62.3%. The concentrate, however, is too low-grade to be considered a commercial product. Flotation after sulphidization with various reagents was next tried. Sulphuretted hydrogen gas, sodium sulphide, and calcium polysulphide all are effective. Any one of these serves the purpose, but most of the work was done with sodium sulphide (fused, carrying 60% Na_2S) on account of its being available in a convenient form. At El Favor calcium polysulphide made locally would probably prove the least expensive.

It was learned early that the silver rebellious to cyanide was equally rebellious to flotation. That is to say,

flotation as developed up to the present time appears to have no effect on the rebellious silver, recovering only the silver mineral soluble in cyanide. This certainly is unfortunate; were it the other way the manganese-silver problem would be solved by flotation of the cyanide tailing or the reverse. A few tests, however, demonstrated that the flotation-concentrate yields its silver to cyanide, whereas the silver remaining after flotation is insoluble in cyanide. Furthermore, flotation after cyanidation fails to yield a silver-bearing concentrate. It would appear therefore that while the results of flotation experiments are especially interesting at this time on account of the scarcity and high price of cyanide and zinc, they do not offer a solution of the manganese-silver problem as such. The sodium sulphide used for sulphidizing the ore has a double action on the silver: The soluble silver is sulphidized and rendered floatable, and in addition a part of the rebellious silver is altered to a form soluble in cyanide. This recalls the Wood report to the effect that sodium sulphide reduces the manganese and frees the silver to cyanide. The observation as to its erratic behavior is also confirmed in that while a 10 to 20% additional extraction is consistently maintained, Mr. Neal has not been able so far, by a series of careful experiments, to better this result, even by the use of a large excess of the reagent.

Another interesting point is that by concentration of the tailing from flotation plus cyaniding, an additional 10% of the silver in the ore can be recovered in the form of a concentrate of commercial value. As high as 100 oz. silver per ton has been attained. That is to say, a sample that had been properly sulphidized and floated in the Janney machine, and the tailing from this cyanided, would yield a further 10% extraction by table concentration of the cyanide tailing. It is to be noted that this is just what is normally extracted on the Wilfley tables in the El Favor mill, and it seems likely that the operation of the Wilfleys in conjunction with a flotation unit would increase the recovery by that amount.

The sulphidization of the ore is accomplished by simply agitating in a weak solution of the alkaline sulphide. At the outset this was done in a bottle previous to flotation, but the time was gradually shortened to a point where the operation was carried out right in the flotation machine. The total extraction by flotation, plus cyanidation, plus concentration, is therefore 71.3% of the assay value.

Summary. The processes investigated in this research fall naturally into two classes—those requiring dry crushing and those adapted to a wet pulp. Considered strictly on their merits as metallurgical processes, Mr. Neal prefers the former, and is of the opinion that either a chloridizing or a reducing roast, followed by cyaniding, offers an acceptable process for ores of this class. The El Favor mill, however, is arranged for wet crushing, so that under anything like equal efficiency a process adapted to wet crushing would have the preference. The chloridizing roast on these ores is not new. The reducing roast is, so far as Mr. Neal is aware, untried on a working scale, but as the volatilization loss would be less than that expected in salt-roasting, and might easily be *nil*, the process has merits that deserve serious consideration. The low grade of the concentrate obtained by magnetic and electro-static processes, necessitating local treatment of the concentrate, is a serious disadvantage; and it is questionable whether the apparent advantages would not be off-set by the greater complexity of plant required. Almost certainly this would be the case in a small mill. The Hamilton process, modified by the use of additional reagents, appeals strongly on account of the high extractions obtained. It is the only process tried that can be said to offer a real solution of the trouble—the others are makeshifts. In the practical application of this process there seems to be no way of avoiding a double treatment, the first working in acid solution and the second in alkaline. A solvent for silver that would not be destroyed by acid, or that would be so inexpensive that a considerable loss could be allowed, would solve the problem, but none is known. The loss of sulphur in the process is an unknown factor, and until the result of commercial operation is made known, it is likely to remain so. The flotation process does not profess to solve the difficulty, but possesses many features that are attractive at the present time. Even if the Mexican would compose his affairs, it is a question whether the El Favor could count on securing a steady supply of cyanide. Further, at the present prices of cyanide and zinc, it appears that the cost of realizing the silver in a high-grade concentrate might well be less than the cost of producing silver bars at the mine by cyanidation. A flotation unit is a comparatively inexpensive machine, and could be put in at the El Favor mill without material alteration of the flow-sheet. The process could indeed be tried on a commercial scale at less expense than would be incurred by a similar test of any of the other processes proposed.

In the discussion of Mr. Neal's paper, H. A. White, vice-president of the Society, considered it obvious that some oxide of manganese is responsible, and then only when all the silver is not in the form of sulphide. This deduction is based on experiments. Probably no method that does not involve the destruction of MnO_2 can yield a high extraction. Research must therefore be made in this direction, one suggestion being to utilize the fact that carbon monoxide at low temperatures, even below red heat, has a powerful action upon manganese di-oxide. F. Wartenweiler gave results of tests made in 1907-8 on a silver-gold tailing and ore carrying pyrolusite in large quantity. The tailing, assaying 4.2 oz. of silver and 0.05 oz. of gold per ton, was leached with an 18% salt solution, which had been charged with chlorine electrolytically generated by passing through an absorption-tower. The recovery was 64.3% of the silver and 75% of the gold. The precious metals were precipitated on lead shavings. The partly oxidized silver-gold ore was roasted with 4% of salt, then leached with the salt solution (18% NaCl and 0.2% free Cl), giving an extraction of 90.7% of the silver and 75% of the gold.

FIG. 3. OUTSIDE OF THE PLANT.

FIG. 5. ANOTHER VIEW.

Zinc Oxide From Lead Slag

By H. B. Pulsifer and George Perlstein

INTRODUCTION. The noteworthy process that Hedges and Divine inaugurated at South Chicago last year for the recovery of zinc from lead blast-furnace slag is being used with such success that it is worth describing in some detail.

The material from which the zinc oxide is recovered is waste slag from the former lead-smelting and lead-refining operations of the once active National plant of the American Smelting & Refining Co. on the lake-front at South Chicago. The process consists in again putting this slag through a blast-furnace with excess of coke and some limestone. The zinc is expelled from the slag, partly by reduction and partly by replacement, the vapor burns to oxide in the stack and flues and is caught in bags after the gases have been sufficiently cooled.

After one year's operation under lease by Hedges and Divine the company failed to renew their lease and is now operating for itself under much greater pressure. A second furnace has been installed, extensive flues constructed, and a new bag-house to accommodate 1200 bags, each 20 in. by 30 ft. By crowding both the furnaces and the new facilities for cooling and bagging, the tonnage treated has been greatly augmented, allowing a probably greater margin of profit. We shall not attempt to give any details of the most recent developments but hold ourselves to the operations of the year from April 1915 to April 1916, when the plant was under the control of B. F. Hedges and R. D. Divine.

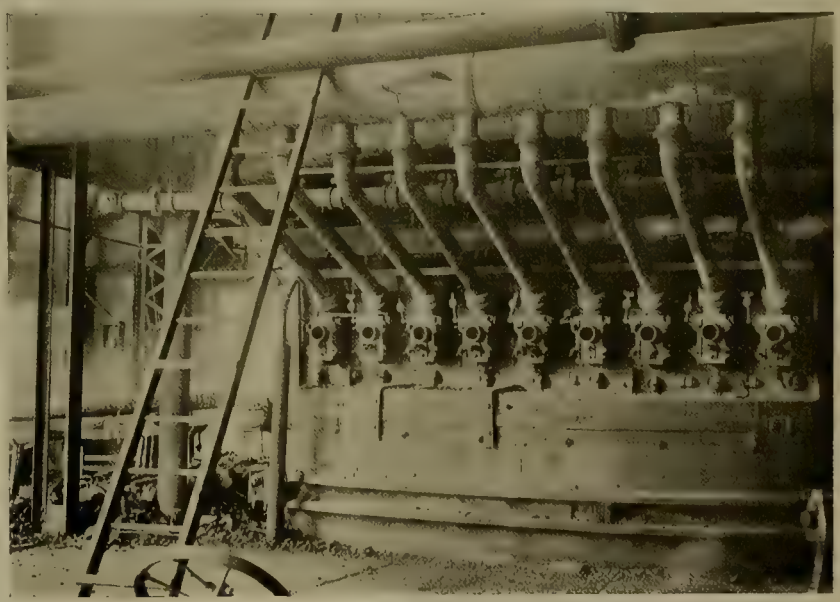


FIG. 1. THE REMODELED LEAD FURNACE.

CHEMISTRY OF THE PROCESS. Although the process itself is extremely simple, the chemistry is not as yet sharply defined. This is probably due to the lack of

knowledge as to the exact composition of the raw material. In the old slags the zinc is presumably present as oxide, silicate, and oxide dissolved in silicate. Messrs. Hedges and Divine first worked on the hypothesis that the zinc was present mainly as oxide; later they came to the conclusion that the silicate predominates.

What zinc is freed has to be reduced to the metallic state and have its vapor forced up through the charge column. With from 25 to 35% of coke on the charge the reduction is strong and the temperature high, as lead-furnaces go. Very likely the silicate of zinc, and much of the oxide dissolved in the silicate, resists even this strong reduction, for, as run during the first year, only about half of the contained zinc was recovered.

A particular balance of conditions was finally hit upon as best expressing the economics of the smelting. The slag contained some 2% of lead and if the temperature of the smelting-zone became too hot all of this lead would be driven off with the zinc vapor. Too gentle reduction failed to yield much zinc. Accordingly, it was found most satisfactory to maintain a condition which would let the lead run out as metal with the slag, thereby being recovered as bullion, while some 50% of the zinc was given off from the slag. Thus a low lead oxide was available for the market and a silver-lead bullion made an additional source of profit.

We are informed that the most recent operations are nearly a continuation of this practice; possibly less attention being given to recovering the lead in the first furnace, while the slag from the first furnace is re-smelted in the second with further recovery of the zinc. The oxide recovered is thus a mixture, and with such a high zinc extraction the lead is not unduly high after all.

During the first year of operations, when the only furnace was run much like an ordinary lead-furnace except for the excess coke and hot-top, considerable lead-bullion and antimonial-speiss were separated from the slag and amounted to a large part of the profit. During this period also the chemical end of the process finished immediately over the charge; with the burning of the monoxide and zinc vapor in the large brick stack of the furnace, directly after exit from the layers of charge, nothing further remained but to cool the gas and fume and collect the latter in suitable receptacles.

Outline of Mechanical Operations. Owing to the rather compact arrangement of slag, furnace, flues, and bag-house the mechanical operations are brief and directly to the point.

A Browning locomotive-crane raises the raw material from the old dumping-ground, be it slightly above or even below the level of the lake-water. A run of a few yards and the bucket is opened over the high hopper which feeds into buggies at the end of the furnace.

Men push or shovel the charge-mixture through the low opening onto the top of the charge-column. An illustration of the furnace-stack and the low feed-openings was given in an article on this same subject in *Metallurgical and Chemical Engineering* of November 1, 1915, by the senior author. A steel flue leads horizontally from just above the feed-floor level through which the fume and gases pass toward the bag-house.

Fig. 1 shows the remodeled furnace as adapted to the new operations after its many years of smelting for lead. It is seen that the crucible was raised a foot above its former height and the well discontinued. This was to give elevation for the flow of slag through a small settler into the granulating-tank at the edge of the building.

Fig. 2 is taken from the edge of the tank and shows the slag flowing from the furnace through the settler. The slag is tapped at intervals and although rather short with lime is fluid enough to reach the water and granulate nicely. A bottom tap in the settler allows the bullion to be run into molds; the speiss (often mixed with matte) is broken away from the slag and piled until enough accumulates to make a shipment to some other lead-refinery. The granulated slag is raised by the crane and returned to a new pile near its original location.

Coke and limestone are received and delivered by the equipment remaining from the former smelting operations of the plant.

It is understood that the 1916 improvements have only slightly altered the arrangements, as would be necessary by the installation of the second furnace at the side of this No. 1 furnace.

The first year of operating the gases and fume traveled through a length of flue some 700 ft. long before reaching the fan, the bagging system, and passing into the main 150-ft. stack. This flue had various sizes and shapes of section and has been completely discarded this year.

Large and long steel flues have replaced the smaller ones of former days; the Prinz & Rau machines have given place to the huge bag-house seen in Fig. 3. For some time they used the outside levers to shake the bags as actually posed in Fig. 4. It is understood that this device did not prove satisfactory, for the levers are little used of late. Doubtless the bags are now shaken by hand inside and individually.

The general character of the steel flue is evident from Fig. 5, which shows it elevated to cross over the tracks just before connecting with the fan and thence to the bag-house. In this view the bag-house is still only partly finished.

When the Prinz & Rau machines were used the zinc oxide collected in the little bags was delivered directly into paper bags that were piled in cars for shipment. An attendant had merely to remove the bags as they became full and place an empty one. With the new methods and larger tonnage, other ways of handling and packing are of course used.

It is thus seen that this method of recovering zinc oxide is remarkably simple in principle and operation. The most approved recent practice does not allow large amounts of zinc in lead ores, as formerly, but lead refineries using the Parkes process do still discard great amounts of zinc from the desilverization to get ultimately into a blast-furnace slag. A more efficient zinc recovery is not yet generally accepted, although Divine worked

out a promising method* at this same plant before it was abandoned as a lead-refinery.

It was naturally inferred that if the new recovery would work on the old National dumps it could also be used to profit wherever a similar dump contained a suitable amount of zinc. Hedges & Divine some time ago leased the old dump at Aurora, Illinois, and soon will be recovering oxide from that plant's former operations. The American company also started the process on slag at the Omaha (Nebraska) plant, and, in a rather small

FIG. 2. RUNNING SLAG THROUGH THE SPOUT AND SETTLER TOWARD THE GRANULATING-TANK.

way, are doing the same thing there. The process is more than likely to extend to any suitable dump in the West where conditions for marketing the oxide may allow profitable work.

DETAILS OF THE BLAST-FURNACE. As the gist of the whole process lies in the blast-furnace work a few details as to how operations were carried out by Hedges & Divine will conclude our account.

The dump-slag analyses to average silica, 33%; lime, 20%; iron oxide, 18%; zinc, 12%; lead, 1.5%. The furnace was run under 12-oz. blast-pressure to smelt 65 tons of slag in 24 hours. Charges were made up of slag, 2400 lb.; coke, 600 lb.; limestone, 290 lb. Every 20 minutes one of these charges would be shoveled into the furnace by hand.

The old smelting-plant had two rectangular lead-furnaces, five water-jackets with five tuyeres on each side. One furnace was torn down at the dismantling of the plant but the one salvaged by Hedges & Divine was lengthened out to nine tuyeres on a side. The curb was raised a foot and the crucible filled to slope from the back to the single tap at the front. The cast-iron jackets are an inch thick and fitted with the tuyere-boxes as in Fig. 1. The remodeled furnace has thus a size of 46 by 156 in. at the tuyeres and a 12-ft. charge-column.

FIG. 4. OUTSIDE LEVER-SHAKING AT SOUTH CHICAGO.

The furnace is run with the top almost at a red heat; in fact, it is quite so just before a fresh charge is shoveled in. The charge decrepitates vigorously while the gases flicker with a greenish flame as the monoxide and zinc vapor burn at the inrush of air through the feed-doors.

Little chemical work was found necessary for smelting control because the slag had, of course, once flowed from a furnace and with the new replacement of zinc for lime would be even more fusible than at first.

The Iroquois Iron Works has recently purchased the eight or nine acres of the old National plant for $107,000 and the American company will doubtless hasten to recover as much oxide as possible before the ground has to be turned over to its new owners.

*Trans. Am. Inst. Min. Engrs., XLIX; 814 (1915).

The Miami Appeal

Interpretation of the First Patent in Suit by the Supreme Court

*The first finding of the Supreme Court relative to patent No. 835,120 is set forth in the following statement quoted from the court's opinion:

"It is clear that in the prior art, as it is developed in this record, it was well known that oil and oily substances had a selective affinity or attraction for, and would unite mechanically with, the minute particles of metal and metallic compounds found in crushed or powdered ores, but would not so unite with the quartz, or rocky non-metallic material, called 'gangue.' Haynes' British patent (1860), and United States patents, Everson (1885), Robson (1897) and Elmore (1901). It was also well known that this selective property of oils and oily substances was increased when applied to some ores by the addition of a small amount of acid to the ore and water used in process of concentration. United States patents, Everson (1885), Elmore (1901), and Cattermole (1904)."

The precise function performed by the "selective affinity" of oil and the reason that acid increases this selective affinity do not appear to be well understood, but the facts were, as stated by the court, known long before date of the first patent in suit.

The art antecedent to patent No. 835,120 is stated by the Supreme Court to be divided into two classes. The court states its views upon this point in the following passage quoted from its opinion:

"The processes, of this general character, described in the prior patents may be roughly divided into two classes. The process in the patents of the first class is called in the record the 'Surface Flotation Process' and it depends for its usefulness on the oil used being sufficient to collect and hold in mechanical suspension the small particles of metal and metalliferous compounds and by its buoyancy to carry them to the surface of the mixture of ore, water, and oil, thus making it possible, by methods familiar to persons skilled in the art, to float off the concentrate thus obtained into any desired receptacle. The waste material, or gangue, not being affected by the oil and being heavier than water, sinks to the bottom of the containing vessel and may be disposed of as desired.

"The process of the other class, called in the record the 'Metal Sinking Process,' reverses the action of the Surface Flotation Process and is illustrated by the Cattermole U. S. patent, No. 777,273, in which oil is used to the extent of 4% to 6% to 10% of the weight of the metalliferous mineral matter, depending on the character of the ore, for the purpose of agglomerating the oil-coated concentrate into granules heavier than water, so that they will sink to the bottom of the containing vessel, permitting the gangue to be carried away by an upward flowing stream of water."

After so classifying the prior art the Supreme Court defines the process of patent No. 835,120 as follows:

"The process of the patent in suit, as described and practiced, consists in the use of an amount of oil which is 'critical,' and minute as compared with the amount used in prior processes 'amounting to a fraction of one per cent on the ore,' and in so impregnating with air the mass of ore and water used by agitation—'by beating the air into the mass'—as to cause to rise to the surface of the mass or pulp, a froth, peculiarly coherent and persistent in character, which is composed of air bubbles with only a trace of oil in them, which carry in mechanical suspension a very high percentage of the metal and metalliferous particles of ore which were contained in the mass of crushed ore subjected to treatment. This froth can be removed and the metal recovered by processes with which the patent is not concerned."

It will be noted that in the passage above quoted the Supreme Court distinctly and explicitly defines the patented process as comprising all of the following named factors: (1) the use of a minute quantity of oil "amounting to a fraction of one per cent on the ore"; (2) impregnating the mass of ore and water with air "by agitation—'by beating the air into the mass'"; and (3) so "as to cause to rise to the surface of the mass, or pulp, a froth, pecularly coherent and persistent in character."

As will appear in the discussion of the process practiced by defendant, defendant does not introduce air "by agitation—by beating the air into the mass," and does not form a froth that is "peculiarly coherent and persistent in character," but, on the contrary, defendant's process results in the formation of bubbles so fragile and evanescent that they exist only while supported by the incoming current of air and which collapse instantly the air supply is terminated. The instrumentality for introducing air employed by defendant is different from that described and claimed in patent No. 835,120 and found by the Supreme Court to be characteristic of the patented process, and the resulting bubbles or froth are as transient as any material thing can be and still exist, and in this respect are diametrically opposite to the "peculiarly coherent and persistent" froth which the Supreme Court finds to be a distinguishing characteristic of the process described and claimed in patent No. 835,120.

*Abstract from brief presented by the defendants to U. S. Circuit Court of Appeals for the Third District, in suit with Minerals Separation, Ltd.

The process described and claimed in patent 835,120 is further defined by the Supreme Court as comprising the introduction of air into the mixture by agitation in the following passage from the opinion of the Supreme Court, in which passage the court states that the extent of agitation was increased as the amount of oil was progressively decreased.

"It was promptly recognized by the patentees that this froth was not due to the liberation of gas in the mass treated by the action of the dilute acid used, and its formation was at once attributed in large part to the presence of the air introduced into the mixture by the agitation which had been resorted to to mix the oil with the particles of crushed ore, which air, in bubbles, attached itself to the mineral particles, slightly coated as they were with what was necessarily an infinitesimal amount of oil, and floated them to the surface. The extent of the agitation of the mass had been increased as the experiments proceeded until the 'series of Gabbett mixers, fitted with the usual baffles, were speeded at from 1000 to 1100 revolutions per minute.' "

Following the passage above quoted the Supreme Court quotes a passage from the testimony of plaintiff's expert, Adolf Liebmann, stating that the court is convinced that this expert has not overstated the facts. The court, in effect, adopts the expert's statement as a statement of the court's finding. Following is the part of Dr. Liebmann's testimony quoted and adopted by the Supreme Court:

" 'The present invention differs essentially from all previous results. It is true that oil is one of the substances used, but it is used in quantities much smaller than was ever heard of, and it produces a result never obtained, before. The minerals are obtained in a froth of a peculiar character, consisting of air bubbles which in their covering film have the minerals embedded in such manner that they form a complete surface all over the bubbles. A remarkable fact with regard to this froth is that, although the very light and easily destructible air bubbles are covered with a heavy mineral, yet the froth is stable and utterly different from any froth known before, being so permanent in character that I have personally seen it stand for twenty-four hours without any change having taken place. The simplicity of the operation, as compared with prior attempts, is startling. All that has to be done is to add a minute quantity of oil to the pulp to which acid may or may not be added, agitate for from two and one-half to ten minutes and then after a few seconds collect from the surface the froth which will contain a large percentage of the minerals present in the ore.' "

In the passage above quoted the first characteristic of plaintiff's process dwelt upon is the use of a small amount of oil; the next characteristic referred to is the "froth of a peculiar character" resulting from the process; next is a reference to the fact that "the froth is stable and utterly different from any froth known before," after which it is stated that the froth is so permanent in character that it will stand for twenty-four hours without change; the last characteristic of the process referred to is the necessity of agitating the mixture for the purpose of producing the froth. Except for the fact that defendant uses the most economical quantity of oil possible in its operations there is absolutely nothing in common between defendant's process and that defined in the above quoted passage. The froth formed as a result of defendant's process has not the peculiar characteristics referred to, the mineral in the froth does not form a complete surface over the bubbles, the froth is not stable, the froth is not different from previous froths, but is identical with that formed by the use of antecedent processes, the froth formed by defendant is not so permanent as to remain unaltered for twenty-four hours or for twenty-four seconds, but collapses instantly upon cessation of the air supply through the porous bottom of the vessel; and, furthermore, defendant does not bring about the introduction of air and froth formation by agitation, but, as above stated, by causing air bubbles to percolate upwardly through the porous bottom of the vessel containing the mixture.

In the part of the opinion of the Supreme Court following the passage above quoted the court again defines the process of patent No. 835,120 in the following terms:

"It is not necessary for us to go into a detailed examination of the process in suit to distinguish it from the processes of the patents relied on as anticipations, convinced as we are that the small amount of oil used makes it clear that the lifting force which separates the metallic particles of the pulp from the other substances of it is not to be found principally in the buoyancy of the oil used, as was the case in prior processes, but that this force is to be found, chiefly, in the buoyancy of the air bubbles introduced into the mixture by an agitation greater than and different from that which had been resorted to before and that this advance on the prior art and the resulting froth concentrate so different from the product of other processes make of it a patentable discovery as new and original as it has proved useful and economical."

In the passage above quoted the Supreme Court, by implication, finds that the prior art processes depend upon the buoyancy of the oil to float the mineral, while the process of patent No. 835,120, using a small amount of oil, is found to depend upon the buoyancy of the air bubbles introduced into the mixture by agitation. The court goes farther and defines the agitation forming part of the process of patent No. 835,120 as "greater than and different from that which had been resorted to before," thus explicitly limiting patent No. 835,120 to the combination of the use of a small amount of oil not only with agitation, but with agitation of a peculiar character, namely, "agitation greater than and different from that which had been resorted to before." The court then states that the procedure so defined constitutes an "advance on the prior art," and the court finds

that "the resulting froth concentrates so different from the product of other processes make of it a patentable discovery." Language could not be framed more explicitly defining and limiting the process of patent No. 835,120 as deriving its novelty and patentability not from the small amount of oil merely, but from the combination of the use of such small quantity of oil with a greater and novel agitation giving rise to a new result, namely, froth concentrates different from the product of prior processes. In view of this explicit interpretation of patent No. 835,120, we maintain that the Supreme Court has excluded from the scope of patent No. 835,120 operations such as practiced by defendant, wherein there is no mechanical agitation whatever for the purpose of introducing air, wherein no mechanical agitation at all is necessary for any purpose, to say nothing of a peculiar and novel degree of agitation, and wherein the result is not the new result defined by the Supreme Court, but is the result attained in prior processes in which air was introduced into the mixture in precisely the manner practiced by defendant.

In reference made by the Supreme Court to decisions made by the British courts the Supreme Court again expresses its conclusion that one of the elements of novelty of the process of patent No. 835,120 is the floating of the mineral particles by the buoyancy of the air bubbles as distinguished from floating the particles by the buoyancy of oil. Nowhere in its opinion, however, does the Supreme Court, even by implication, suggest that patent No. 835,120 confers a monopoly for the flotation of mineral particles by the buoyancy of air except in combination with the other features of the patented process, namely, agitation of a peculiar character to beat air into the mixture and the resulting formation of a froth of concentrates different from the product of prior processes. The prior art contains many instances of the flotation of mineral particles by the buoyancy of air and other gases, thus rendering impossible the granting of any legal monopoly upon the bare and broad idea of concentration by utilizing the buoyancy of air. Furthermore, the Supreme Court has often ruled, in cases discussed at page —— of this brief, that patents for principles or laws of nature, separate and apart from the means by which those principles or laws are utilized cannot be sustained.

In the concluding paragraph of the opinion of the Supreme Court reference is made to the decision of the District Court in the Hyde case, which decision the Supreme Court reverses to the extent of declaring claims 9, 10 and 11 invalid. Claims 9, 10 and 11 define the amount of oil as "a small quantity." The claims sustained by the Supreme Court limit the amount of oil to a fraction of 1% by weight relative to the ore. In this finding the Supreme Court imposes a further limitation upon patent No. 835,120, confining that patent not only to a greater degree of agitation and the novel form of froth referred to by the court, but further restricting the patent to the use of a fraction of 1% of oil relative to the ore. In this connection the court makes the following statement:

"As we have pointed out in this opinion, there were many investigators at work in this field to which the process in suit relates when the patentees came into it, and it was while engaged in study of prior kindred processes that their discovery was made. While the evidence in the case makes it clear that they discovered the final step, which converted experiment into solution, 'turned failure into success' (*The Barbed Wire Patent,* 143 U. S., 275), yet the investigations preceding were so informing that this final step was not a long one and the patent must be confined to the results obtained by the use of oil within the proportions often described in the testimony and in the claims of the patent as 'critical proportions' 'amounting to a fraction of one per cent on the ore,' and therefore the decree of this court will be that the patent is valid as to claims No. 1, 2, 3, 5, 6, 7, and 12, and that the defendant infringed these claims, but that it is invalid as to claims 9, 10, and 11."

MINE-WATER usually contains minerals in solution, the most common being calcium carbonate and the sulphate of magnesium, aluminum, iron, and copper. Other minerals are often present, but usually in less amount than either of those mentioned. The water of many mines is used for drinking and other domestic purposes, but there is always danger in such use of mine-water, particularly that from operating mines, due to the presence of organic matter that is far more harmful than any mineral the water may hold in solution. Generally, if the mine-water is unfit for domestic use its disagreeable taste will be a sufficient warning. Water issuing from veins containing a large amount of sulphide mineral is often heavily charged with the salts of iron and sometimes of copper, and it also occasionally contains some free sulphuric acid. There is little danger of anyone taking more than a single swallow of water of this description, as it is strongly astringent and often bitter and most disagreeable. In the early days of the development of the mines of Western Australia, the only water available for any use was that from the mine shafts and this was so salt—due to the presence of sodium chloride—that it had to be distilled and condensed before it could be utilized for steam-making, or for any other purpose. The minerals, in solution in water flowing from springs, or from veins, indicate the presence of these minerals in the rocks, or in the vein from which the water flows, but only the base metals, which on oxidation produce soluble sulphates, are likely to be detected in solution in water; neither gold, silver, zinc, nor lead will be found in such water by ordinary methods of analysis.

IRON ORE reserves of Spain are stated to be 700,000,000 tons of 50% ore. The province credited with the largest deposits is Leon, where there is 150,000,000 tons. Teruel has 135,000,000 tons, and Viscaya, 70,000,000 tons. About 9,000,000 tons has been mined annually during the past ten years.

Mining in Utah

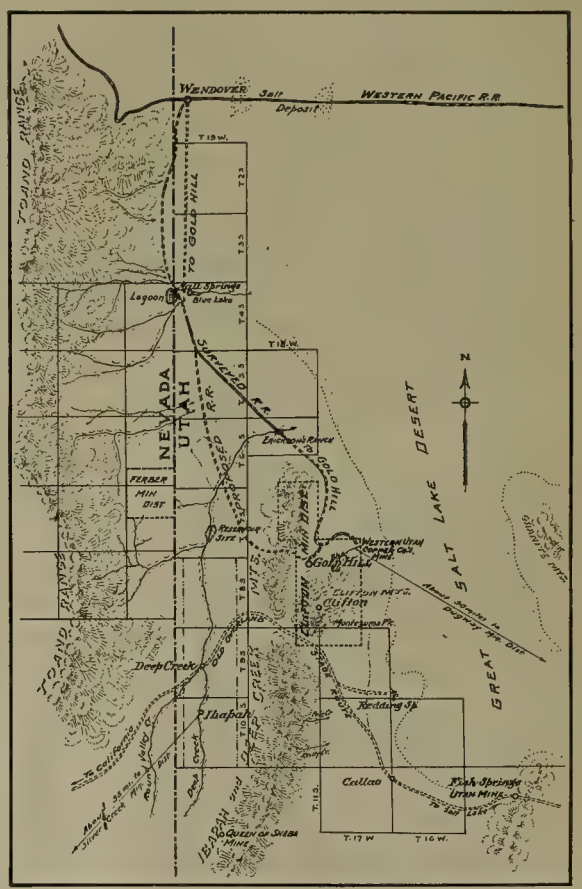
By L. O. Howard

Official statistics having been duly published, it is of little interest to dwell long on the figures that show the remarkable record of Utah in 1916. It is more to the point to consider some of the possibilities of the present year by aid of these statistics. Utah occupies a unique position among the Western mining states in that it depends upon the base metals almost exclusively for its importance. While reaping the benefit of high prices for these metals, it has not had to meet the unfortunate situation peculiar to a State depending solely upon the precious metals. Cyanide-plants are notably absent. The use of expensive and scarce chemicals, such as cyanide and zinc-dust, is at a minimum. Although the production of gold and silver attained a respectable total in 1916, it nearly all came as a by-product from the ores of lead, copper, and zinc.

As an indication of the opinion that may be held by the smelting companies as to the immediate future of the mining industry may be cited the many improvements started during the past year and now in course of construction. Arrangements have been made to double the capacity of the copper-plant of the Garfield Smelting Co., which operated four blast-furnaces and five reverberatories in 1916, treating 3500 tons per day of metal-bearing charge. The capacity of the American Smelting & Refining Co.'s lead-plant at Murray is also to be increased. Six blast-furnaces were operated last year on ore from Utah, Colorado, Idaho, Nevada, and more distant States. The International plant at Tooele had the satisfaction of seeing its copper department busy for the first time since its erection, for it had four out of five reverberatories at work, treating 1500 tons of ore daily, thus slightly exceeding the capacity of its five lead-furnaces, which treated about 100 tons less, each day. Separate Cottrell plants are now treating the gases from the Dwight-Lloyd sintering-plant and the converters.

Operations of the United States Smelting, Refining & Mining Co. at Midvale, besides its electro-static and wet-concentrating mills and its 5-furnace lead-plant, now include the regular production of arsenic, electrolytic cadmium, and a small amount of thallium.

A number of new industries are getting into their stride and should increase Utah's production of unusual materials. Potash has attracted the most attention. Valuable salts are obtained from alunite at Marysvale and from the brine of Great Salt lake. Marysvale, which is in Piute county, at the southern terminus of the Sevier & San Pete branch of the Denver & Rio Grande railroad, has rapidly taken a position as one of the State's important and interesting districts. The Mineral Products Co. is in a position to produce 40 to 50 tons of potassium sulphate daily. The experimental stage has been successfully passed, and attention is now centred on the by-products. The possibilities with respect to these are most promising, and more interesting perhaps than the winning of the various valuable products from the brines of the Western lakes, as the former bear more resemblance to other mining and metallurgical industries.



SKETCH SHOWING RAILROAD NEARLY COMPLETED FROM WENDOVER TO GOLD HILL, UTAH, AND AREA TRIBUTARY THERETO.

The alunite as mined will average 35 to 37% Al_2O_3 and 10 to 12% K_2O. Alunite contains also 13% water and about 38% SO_3. By 'roasting,' or, more properly, calcining, all of the water and three-quarters of the sulphur tri-oxide may be eliminated, leaving a calcined product amounting to a little less than 60% of the initial charge, and assaying about 18% K_2O and 61%

Al_2O_3. The potash, expressed as sulphate, amounts to about 32%. Lixiviation with water will remove 90 to 95% of the potassium sulphate, leaving nearly pure alumina, for which uses will soon be developed. In fact, it is expected that during the current year this material will be utilized either in the manufacture of 'refractories,' for which it is especially adapted, or as a source of aluminum. I have it on good authority that some of this residue has been treated at Niagara Falls for the production of aluminum at a cost that would insure a profit under normal market conditions. This residue would make an unusually pure and high-grade ore of aluminum, and cannot be disregarded as a potential factor in aluminum production. The Florence Mining & Milling Co. has under construction a plant that should begin operations in the early summer. It is planned, I believe, to ship calcined alunite East for treatment. It is also distinctly possible that a market will be found for the calcined alunite without further treatment. Transportation rates exercise a controlling influence over metallurgical developments.

This year will also bring about a great extension in the productive area at Marysvale. Large deposits of alunite of lower grade have been found on the side of the Sevier valley opposite the producing mines, and we may expect to see the usual experience repeated—the continued extension of a mineral district much beyond the boundaries generally accepted.

Shipments of potash salts are being made also by the Utah Chemical Co. and the Salt Lake Chemical Co. with plants near Saltair and Grants on the shore of the Great Salt lake. The waters of the lake are the source of the potash, the Utah company taking the concentrated brine from the evaporating ponds of the Inland Salt company.

Marysvale has other claims to prominence as the shipping-point for a fair output of 45 to 50% manganese ore, which was forwarded to Illinois and Pennsylvania. A mill for treating antimony ore was built near Marysvale and is said to be turning out six tons of 50% concentrate daily. This is the only antimony property now in operation in the State, although a few tons of crude ore was shipped from near Brigham City, in Box Elder county, while high prices prevailed last spring. The present state of the antimony business does not encourage an increase in production, development, or prospecting.

There is certain to be a noteworthy output of sulphuric acid in 1917. The Garfield Chemical & Manufacturing Corporation has a 100-ton plant which ran a few days in December on gas from two Herreshoff roasters at the plant of the Garfield Smelting Co., but had difficulties owing to the extreme cold. A daily production of at least 150 tons of acid may be expected confidently later in the year.

This year will also see the inauguration of a hydrometallurgical process for copper on a large scale. The Utah Copper Co. expects to have its sulphuric-acid leaching-plant in operation by July. A production of 10 to 15 tons per day of electrolytic spelter may be anticipated soon from Park City, where the Judge Mining & Smelting Co. has completed its plant and begun to warm up its furnaces. The results of experiments with cathodes is awaited with great interest by metallurgists. Incidentally, Park City should have a record production in 1917. The Silver King Coalition has enlarged its mill. The Silver King Consolidated has leased and started the old Grasselli mill. Both of the large tailing-plants, the Big Four Exploration and Broadwater mills, have increased or are about to increase their capacity and will go into operation again as soon as the weather moderates.

The first full-year of milling on the American Fork is in sight, the Fissures Exploration Co. having started a 50-ton plant. The completion of a power-line into the district should result in maximum activity in 1917. The Alta district should have a good year, having received more adequate transportation facilities too late for the effect to be felt in 1916. In Big Cottonwood also a feasible method of hauling has finally been found in the use of motor-trucks and trailers. At present, however, the Cardiff is shipping about 100 tons per day on sleds, which, owing to the unusual snowfall of Christmas week and since, can haul into the smelter-yards without reloading—a necessity in other winters.

Since the smelters have met the increased mine production with enlargements of plants, the congestion of last summer is not likely to be repeated, and the small producer of copper ore, to mention only the worst sufferer in 1916, will be able to market his ore and continue development on a scale impossible of realization in the past.

For many years the Deep Creek district in Tooele county has struggled against inadequate transportation facilities. Numerous projects for building a railroad into the district have budded but never blossomed, until the Deep Creek railroad has become a by-word. This year brings the realization of the 20-year old dream, for a road is now under construction from Wendover on the Western Pacific railroad to Goodwin, or Gold Hill, in the heart of the district. With its completion early this year will come the beginning of shipments from the large deposits of base metals of low grade, and the culmination of a boom now incipient.

Shipments from other scattered districts in Beaver county, and at Ophir and Stockton, will probably maintain the healthy rate of increase noted in 1916. As to the newer zinc districts that became prominent last year, there is an element of doubt. Large developed mines comparable with the newer ones of Idaho are lacking, and while an excellent profit was made considering the small amount of capital invested, most of the new zinc mines are not yet out of the stage where an abnormal market is an essential to successful exploitation. The cream has been skimmed and slow, plodding, and expensive development is now necessary to maintain these properties on the profit side of the ledger. It is to be feared that many of them have had balances recently 'in the red.'

At Tintic and Bingham it is not to be expected that the ratio of increase to past production—high on account of the cumulative acceleration of prosperity—will be maintained. Prices have undoubtedly reached a maximum, and wages also. Although the outlook is excellent for an abnormally prosperous year, there is a limit to possible growth, and long-continued acquaintance will bring out the faults of even our best friend. Friend Prosperity is being analyzed for his faults. His principal one, high cost of living, is just now receiving more attention than his greatest virtue, generally considered to be high wages.

Operations of the Utah Copper Co. and other companies in the Bingham district have received their due share of publicity, so that recapitulation of their successes is unnecessary. Extraordinary performances have become commonplace, and one record is hardly pegged before a new one is made. The severity of the winter will hinder operations and reduce the output for the beginning of the new year.

Although the position of the new mines that are exploiting carbonate of zinc is not as enviable as formerly, there will, without doubt, be an increase in the production of concentrate from sulphide ores. This will come principally from the increased capacity of Park City plants, both crude-ore and tailing-plants; from the operations on the old dumps in other parts of the State, for instance the Caldo mill treating the Horn Silver dumps at Frisco, where 200 tons is to be added to the 650-tons capacity now operating; a new flotation-plant of 300 tons capacity, which commenced operations late in the year on old dumps of the Midvale mill of the United States Smelting Co., and from the additional capacity of the United States electro-static and wet mill at Midvale.

The operation of a cyanide-plant in the Mercur district, is, I believe, the sole exception to the statement that precious metals are not won by direct methods in this State. In the West Dip area, the West Mercur Mines Co. has been operating a mill on the Old Daisy, or Norma, property. A relatively large deposit of medium-grade ore has been the cause of intermittent attempts at treatment for many years past, but no profit had been made for any continuous period, chiefly through lack of the capital necessary to permit economies in operation. The property is now in the hands of strong people and it is distinctly among the possibilities that Mercur will again appear as an important contributor to the State's output of gold.

In the rare-metal industry conditions are likely to become more stabilized. While there is little activity in the carnotite fields, the resumption of operations in Colorado on a large scale and the reported quotation of $100 per ton for ore containing 2% U_3O_8 may presage the resumption of mining for radium in Utah. The position of tungsten is likewise uncertain, although the present market allows profitable operation in some cases. I understand that there has been some development of molybdenite properties under the stimulus of high prices, but the undetermined technique of its metallurgy has so far deterred operators from attempting extensive exploitation.

Had the coal companies been on the 'leak list' of the weather man, their profits could have been greatly increased, but just now the same factors that have caused the excessive demand have operated to curtail output. The farmer's maxim could well be adapted to read, "Mine (and ship) coal while the sun shines."

Hydrocarbons have had a varied career, but profit is mostly among the things to be. Ozokerite received its due share of attention early in the year and one mill commenced treatment. Recently there has been more secrecy as to operations, and I am not informed as to progress. This may be only business policy, or may indicate that the industry has not been so satisfactory as may have been anticipated. One or two small companies have been organized to develop the oil-shale of north-eastern Utah, but details have not been made public. It is a fact recognized by the well-informed that the successful exploitation of this resource is only possible on a large scale. The amount of this shale is so large and the reported content of lighter constituents so great that its possible effect in ameliorating the scarcity of gasoline is a thing to be considered. The possibilities have been known for a long time, and it appears that the utilization of this source of oil is near at hand.

Gasoline Cautions

Gasoline should be kept and used only in small quantities, and used only by experienced employees who realize the danger in using this volatile fluid and know how to handle it safely, says the *Compressed Air Magazine*. Gasoline should be handled in small safety-cans, equipped with safety-gauze and safety-stopper. Gasoline is exceedingly volatile and will vaporize when exposed to the air at any temperature down to 15° below zero. This vapor is nearly three times as heavy as air, and when mixed with the proper quantity of air becomes violently explosive. The vapor will ignite from any open flame, even from a spark of static electricity from a human body, a spark from an emery wheel, or from a sufficiently heated surface. The gasoline vapor, being heavier than air, will naturally seek a lower level, and if confined where there is poor ventilation, will sometimes remain in an explosive condition for months.

TIN RECOVERED by the Tongkah Harbor company, operating at Puket, Siam, during the year ended September 30, 1916, amounted to 1077 tons of 73.1% metal-content. Five dredges dug a total of 3,363,750 cu. yd., equal to 107.65 yd. per hour each. The boats worked 72.35 to 83.86% of the total possible time. The ground yielded 0.717 lb. of tin oxide per cubic yard., equal to 16.4 cents. The cost of operation was 8.12 cents, and other charges 1.15 cents. From the year's profit and previous balance four dividends were paid totaling $290,000.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

SEATTLE, WASHINGTON

PROCEEDINGS AT OPENING OF NEW EXPERIMENT STATION.

Recently there was opened on the campus of the University of Washington, by the U. S. Bureau of Mines, a Mining and Metallurgical Experiment Station, and to celebrate this event the College of Mines of the University held a smoker and open house on the evening of January 12. With this celebration was combined the annual social gathering to welcome the 'shorthorns,' namely the men taking the winter short-course, which is held every year for the particular benefit of prospectors, miners, and others desirous of attending this class of instruction and elementary practice in the laboratory and mill and mining machinery rooms of the College. There were 202 in attendance, exclusive of 50 to 60 men who had been attending a press convention held at the University the same night, and who put in an appearance late in the evening. The following names, constituting about one-third of those present, will give an idea of the representative nature of the gathering:

MINES BUILDING, UNIVERSITY OF WASHINGTON, SEATTLE, MENTIONED IN THIS LETTER.

U. S. BUREAU OF MINES, PACIFIC NORTH-WEST STATION, UNIVERSITY OF WASHINGTON, SEATTLE.

U. S. Bureau of Mines local staff: Dorsey A. Lyon, superintendent of the Experiment Station; G. Watkin Evans, mining engineer; U. B. White, chief clerk; A. M. Felton, and J. J. Corey in charge of the Mine-Rescue Station established here by the U. S. Bureau of Mines in 1910.

University of Washington: Regents Miller Winlock, Seattle, and John A. Rea, Tacoma; president Henry Suzzallo; College of Mines: Milnor Roberts, dean; Joseph Daniels, professor of mining engineering; C. R. Corey, professor of metallurgy; J. L. McAllen, instructor in mining engineering; H. L. Glenn (of the U. S. Assay Office, Seattle) and F. Powell, lecturers. University Mining Society: Jesse Johnson, chairman, and H. G. Boulton, secretary.

A. I. M. E., Seattle Section: C. E. Bogardus, Mel C. Butler, Donald G. Campbell, Glenville A. Collins, Jas. A. Kelly, Chester F. Lee, H. L. Manley, Chas. A. Newhall, Carl H. Reeves, F. H. Richardson, Geo. Rockefeller, Amos Slater, and others.

Other engineers: J. E. Blackwell, Marcel Daly, Glen Dunbar, W. C. Dunbar, C. E. Hill, D. E. Hooker, L. G. Knight, E. A. Loew, J. R. Morrison, R. H. Ober, Capt. A. O. Powell, W. H. Tiedeman, A. L. Valentine, Percy Wright, and many more.

Alaska was represented by A. C. Baldwin, Valdez; M. A. Ellis, Susitna; John D. Leedy, Nome; C. C. Mooers, Seward; H. L. Polson, Ketchikan; E. S. Robe, Knik; C. Simenstad, Valdez, and D. A. Winn, Juneau.

Among those from the United States, not already mentioned, were J. W. Bullock, manager Amador mine, California; F. R. Field, Denver, Colorado; Rufus Buck, Montana; J. T. Gregg, Portland, Oregon; Tom Brown, Sumas, Washington; and the following from Seattle and district—J. L. McPherson of the Alaska Bureau of the Seattle Chamber of Commerce; W. H. Whittier, Fellow of the Industrial Bureau; L. D. Jones, superintendent of Renton Mines; W. E. McMicken, of the Hyde Coal Co.; J. P. Fuller, editor of the *Pacific Builder and Engineer*; H. P. Fogh, Seattle, and many others. From Canada came C. E. Lewis, Dawson, Yukon territory; E. N. Dally, of the Flathead oil country in South-east Kootenay, B. C.; T. M. Daulton, manager of the Placer Mines Co., Atlin, B. C.; Nicol Thompson, president of the Board of Trade of Vancouver, B. C., and E. Jacobs, secretary of the Western Branch of the Canadian Mining Institute, Victoria, B. C.

After a student's orchestra had rendered instrumental selections, there were several addresses, as follows:

The president, Henry Suzzallo said: "On behalf of the University administration I desire to welcome the practical miners, and the friends of the mining industry, to this Mines' Experimental Station, established by the Federal Government in co-operation with the University of Washington. The occasion marks the return of practical men to the training class of the College of Mines, and the opening of an establishment devoted to that practical research work in which the true teacher of mining is ever interested. * * * We are glad to have this work in practical research as a Campus institution associated with our research work in mining and other engineering fields. We bid you welcome to this winter of study in the short courses. We trust that you will profit greatly and at the end return to the practical field of operation to make that fortune to which every world-trained and hard-working miner is entitled."

Dorsey A. Lyon gave information relative to the U. S. Bureau of Mines, its work, and the purposes for which its experiment stations have been established, saying:

"When the Bureau was organized it took over the work of the Technological Branch of the U. S. Geological Survey.

Under a subsequent Act, Congress specifically stated that the work of the Bureau should be (1) the preservation of the health and life of the miner, and (2) the prevention of mineral waste. All the work the Bureau does has either the one or the other of these objects in view. The work of the Bureau has gradually expanded since its organization. The first Bureau station was established at Pittsburg, Pa.; later on stations were established at, respectively, Urbana, Illinois; Denver, Colorado; San Francisco, California; and Salt Lake City, Utah. The work carried on at these several stations is as follows: Pittsburg: coal-testing, testing of explosives, studying mine explosions in the experimental mine, mine-rescue work, study of mine gases, etc. Urbana: study of coals with particular reference to their utilization for fuel and steaming purposes. Denver: study of the recovery of precious metals and their utilization. San Francisco: study of smelter-smoke gases with the purpose of preventing damage, and the recovery and utilization of the volatilized products contained in them. Salt Lake City: study of the low-grade and complex ores which are either too low-grade or too complex to be profitably worked at the present time and hence are liable to be wasted in the mining and treatment of ores that can be mined and treated at a profit. In 1915 Congress authorized the establishment of 10 additional Bureau of Mines' stations, no more than three of which should be established in any one year. In accordance with the provisions of that Act, Congress in 1916 made the money appropriations requisite for the establishment of three stations, the choice of positions for which was left to the Secretary of the Interior, who afterward decided that these stations should be respectively, at Tucson, Arizona; Fairbanks, Alaska, and Seattle, Washington.

"Work at Seattle Station—The work it is proposed to do at the Mining and Metallurgical Experiment Station includes:

(1) Determining how far it may be profitable, and likewise feasible, to use electricity in the recovery of metals from their ores, by (a) electro-thermic processes and (b) electrolytic processes.

(2) Study of the coals of the North-west, and of the west and south-west coast of Alaska, for the purpose of (a) determining how they may be mined with the least possible waste, and (b) the beneficiation of low-grade coals so as to render them suitable for fuels for all purposes.

(3) Study of the problems connected with the ores of the North-west, and of the west and south-west coast of Alaska, in so far as such problems may differ from those now being studied at other stations of the Bureau."

E. Jacobs, of Victoria, B. C., brought greeting from the Western Branch of the Canadian Mining Institute, and expressed gratification at the inauguration, under Federal Government auspices, of an extension of the scope of the mining and metallurgical educational work so long and so zealously and effectively carried on by the College of Mines of the University of Washington. In passing he mentioned that the estimated approximate value of the mineral production of British Columbia in 1916 had been $45,000,000, in the proportion of $35,000,000 for metalliferous minerals, $8,500,000 for coal and coke, and $1,500,000 for miscellaneous products. This compared with $32,440,000 in 1912, the year of previous highest record. The most striking feature of the year was the establishment of electrolytic refineries for copper and zinc, so that as a result of these and earlier achievements at Trail, B. C., the Consolidated Mining & Smelting Co. is now producing there five refined metals, namely, gold, silver, lead, copper, and zinc, a result stated to be unequaled in the world.

Geo. Watkin Evans gave an outline of the work it is proposed to do at the Experiment Station in connection with coal.

J. J. Corey, told of the opening of the Mine-Rescue Training Station on the University Campus nearly seven years ago, and of its useful work done during the intervening years to date. Approximately 900 had been trained in mine-rescue work and first-aid to the injured—401 in mine-rescue work and about 500 in first-aid. With the exception of 75 to 80 trained by officials connected with Bureau Railway Car No. 5, stationed at Billings, Montana, which had made two trips in the State of Washington, all these had received their training at the local station. All University students taking the mining course are required to take the mine-rescue and first-aid training before graduating. Recently there had been added to the equipment of the station Mine-Rescue Truck No. 3, built by the White Motor Truck Co. of Cleveland, Ohio, with body of a special design of the Bureau of Mines. This motor is of 45 hp. and in an emergency the truck can travel at a speed up to 50 miles an hour, carrying a rescue-crew of five men, with all mine-rescue and first-aid equipment and reserve tanks of oxygen and all other necessary supplies.

DEADWOOD, SOUTH DAKOTA

METAL OUTPUT.—POWER EXTENSIONS.—ORO HONDO DEVELOPMENT.

The production of gold in the Black Hills of South Dakota during 1916, amounting to $7,500,000, has been exceeded only once in the history of the region. Tungsten was second in value, namely, $500,000, a record output. Silver, with 212,000 oz. valued at $140,000, was also the largest in years. While 1916 was a highly prosperous year, much is planned for 1917, and it promises to be the banner year.

So far the biggest single undertaking announced, is the construction by the Homestake company of a second hydro-electric plant on the Spearfish river. Late last fall the company purchased the Cascade placer, covering 6 miles of the stream, and adjoining the upper end of the project which was successfully completed some years ago. Construction work on the new plant will start soon; in fact bids have been submitted for the tunnel work, and as soon as the contracts are signed ground will be broken. The water for the new plant will be carried in wood-stave pipe except for one mile, where the canyon cliffs are exceptionally rugged and a tunnel will be used as a conduit. In all the water will be carried five miles, delivered under a 600-ft. head and will develop 3000 hp. Endeavor will be made to complete this project within the year. New installation at the Homestake re-grinding plant is proceeding at a satisfactory rate. Here three 5 by 14-ft. tube-mills are being added to the three tubes and one Hardinge mill already in use. Two Dorr simplex classifiers and additional amalgamating tables are being put in place.

The recent purchase by John T. Milliken, of St. Louis, of the Montezuma and Whizzers property, comprising 150 acres, is taken to indicate that he is satisfied with results of exploration at the Oro Hondo, where he has spent $250,000 during the past two years in exploiting the southerly extension of the Homestake ore formation. A policy of strict secrecy regarding developments in this property has been maintained ever since work was started, so that nothing definite is known regarding disclosures underground. It is known that the shaft is 2000 ft. deep, and that much lateral work and two miles of diamond-drilling have been done from it. Four diamond-drills have been constantly employed for months. It is also generally known that he contemplates sinking the shaft 1500 ft. deeper. This would call for an almost complete re-modeling and replacement of the surface plant. A new engine and head-frame would be required for such additional depth. It is argued that he would scarcely be justified in making these expenditures unless he had found ore, as it is believed that exploration has already penetrated ground where ore should be found, if it continues into the property. The Montezuma and Whizzers adjoins the Homestake on the east, and runs to the western city limits of Deadwood. It covers the locally-called 'big iron dike,' the strongest and most persistent vein outcrop in the Black Hills. It can be traced on the surface for over four miles across hills and gulches. On both the north and the south it is hidden beneath sedimentaries. This vein has never been prospected for more than a few feet below water-level.

JOHANNESBURG, TRANSVAAL

GOLD OUTPUT.—UNDERGROUND DIFFICULTIES.—RAPID SHAFT-SINKING.—FAR EAST RAND.—THE BIG COMPANIES.

It seems opportune at this season (December) of the year to reflect on the doings and achievements of 1916. The production of gold is estimated at 8,972,000 fine ounces, valued at £38,110,000. These figures indicate that the Rand will again pass the previous record which was 8,771,919 oz. worth £37,260,746 in 1915. The quantity sent to the mills is estimated at 28,652,000, against 28,355,175 tons in 1915. This indicates a slight improvement in the grade of ore treated, but as working costs were higher and considerable expense was incurred in connection with the War the estimated profits for the year are appreciably lower.

A feature of 1916 were the increasing difficulties in mining, encountered as greater depths were reached. Several mines on the Rand are now working from 4000 ft. to upward of 5000 ft., at which depths it becomes useless to depend on pillars for supporting the hanging wall, even though they be of larger dimensions. All kinds of packs have been tried, even reinforced concrete supports, but these afford only temporary relief. The only effective support is to take out all of the pillars and completely fill the cavity with sand. Hence the practice of sand-filling is expanding on the Rand each year. During 1916 there were fewer earth tremors than formerly, and probably sand-filling may be credited with this change. The report on earth tremors by the Government Commission made its appearance during the year, the conclusion arrived at being that the shocks were entirely due to mining. Larger pillars and their quicker extraction were recommended, mining without leaving pillars was considered impracticable, and more extensive sand-filling was recommended. Seeing that preparations for mining at depths over 6000 ft. are being made, some method of mining without leaving pillars will have to be adopted in the future.

Another feature of 1916 was the sinking of the Crown Mines No. 14 circular shaft 252 ft. in one month. This was considered a world's record for rapid shaft-sinking. The diameter is 20 ft., and the shaft is being sunk for ventilation purposes.

The Far East Rand attracted more attention locally during 1916 than the remainder of the Rand. The discovery made by E. T. Mellor of the Geological Survey that the 'reef' on the Far East Rand occurs for the most part in elongated, parallel 'patches' or lenses, with the long axis running roughly south-south-east, attracted considerable attention at the time. Between these elongated patches occur areas frequently barren of profitable ore and sometimes the hanging and foot-walls come together. This occurrence is described as a 'barren contact.' This explains why several shafts sunk on the Far East Rand have encountered unpayable reef, and afterwards by driving along the contact have found milling ore. The Brakpan mine is a striking example of this. This discovery by Mr. Mellor shows that only one-half of the 90,000 claims on the Far East Rand can be regarded as profitable.

Several attempts were made to lease some of the mining ground owned by the Government. Its desire was to extract a large share of profits, while the lessees took all the risk. This prevented any business being done. However, in August, two properties were offered on lease with easier terms for those who tendered, and these were taken by the Central Mining & Investment Corporation, and the Consolidated Mines Selection Co. In both cases the successful tenderers control adjoining properties, with which it is intended to work the new areas. New mining legislation to empower the Government to deal with these Far East Rand properties was also under consideration by Parliament, when an agitation was raised in favor of the Government developing the region by means of State mines. The agitation spread until the Government deemed it expedient to appoint a Commission to enquire into and report on the matter. At present (early in December) the Commission is busily occupied taking evidence. During 1916 an attempt was made to induce American capital to come in to develop this territory, and visits were paid by Messrs. Mein and Hoffman on behalf of New York people, but nothing has come of the matter so far.

None of the great consolidated properties on the Rand met with the success expected during 1916. The Randfontein Central has at last got its 1000-stamp mill at work, but for some time has not been able to pay a dividend. The Crown Mines, with the object of making more profits, reduced the stoping widths with generally disastrous results, and has again resorted to the previous method. While these experiments were in full swing the Randfontein gold output exceeded that of the Crown, then the leading producer here. At the East Rand Proprietary Mines the western section of the property proved much broken below the water dike, current development became unsatisfactory, and it looks as though the property will become a 'white elephant.' It was decided to spend £200,000 to test the reef by cross-cutting and shaft-sinking at a depth of 6000 ft., but it cannot be said that the prospects of the reef becoming profitable at depth are encouraging. The Crown Mines has proved the Main Reef series south of the South Rand dike by boring, the results as far as can be ascertained by boring being satisfactory. The leading mines in the Barberton and Lydenburg districts have also done poorly during the year. Seven companies averaged a total of 52,000 tons for 28,000 oz., and a profit of $120,000 per month.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

JUNEAU. On January 27 three large snowslides near Juneau killed two men, carried away power flumes and other mining property, and forced the Alaska Gastineau mine and mill to suspend work.

ARIZONA

In Bulletin No. 44, economic series No. 12, J. Preston Jones of the State Bureau of Mines, covers workmen's compensation. Part I deals with definitions, theories, development, constitutional obstacles, and brief digest of the compensation acts of the United States. Part II discusses the law as applied in Arizona, where it seems to compare favorably with those of most of the other States of the Union.

CHLORIDE. The Jesse Knight syndicate of Salt Lake City has purchased four claims and a fraction in the centre of this district, and will operate under the name of the Bullion Hill Mines Co. A shaft is to be sunk 800 ft., and machinery is to be purchased.

GLOBE. According to A. H. Buckingham of the Globe Commercial Copper Co. the manganese deposit opened by him and W. Wright has widened from 4 to 12 ft. Each miner can break 4 tons per day. The ore returns 38 to 40%. The company is financing operations, also the installation of a concentrator.

OATMAN. An examination of the Gold Ore mine for Moline, Illinois, people has been finished by H. Irving Jones. The reason of this was to determine the size of mill that the company proposed to build at once. Last year there was treated 2000 tons of ore at the Gold Road mill, and the same process as used there will be adopted.

The Fessenden Gold Mining Co. having sold treasury shares, will resume work at once. The property has a vein that parallels the United Eastern. A shaft was sunk 540 ft., and a cross-cut driven to the vein on the 500-ft. level.

The east drift on the 300-ft. level of the Murdock, which has cut several shoots of good ore, encountered soft ground and was turned into the hanging wall where it is proceeding in a silicified rhyolite, containing specks of hematite which pan well. The vein is on a rhyolite-granite contact, the only contact vein yet opened in the district, and was reached after cross-cuttting 62 ft. of silicified rhyolite, which in places carries fair gold-content. The large producing mines of the district are found in a green-stained chloritic-andesite, but rhyolite predominates in the Black Range section, in which is the Murdock. J. Parke Channing is developing the Oatman Syndicate between the Murdock and the Nellie. The Nellie vein is wide, and contains considerable ore of milling grade on the 350-ft. level, where driving is in progress.

The Lucky Boy, south-east of the Aztec workings of the Tom Reed, is cutting a station at 400 ft. preparatory to cross-cutting to the main vein, which is 50 ft. wide on the surface.

The Adams, in the Black Range, is in the vein-casing in the cross-cut at the 400-ft. level and has cut 15 in. of talc in one of the characteristic slips. A steel bulkhead has been set in concrete as a provision against a heavy flow of water. The cross-cut was driven at a point between two ore-shoots that were developed on the surface, and some driving probably will be necessary to get into the ore.

The United Eastern mill has been in constant operation since it started on January 4, and will make the first clean-up in a few days.

PARKER. Extensive development is the order of the day in this district. The producers are shipping from 20 to 250 tons per day each, the Swansea being the largest. Results at the Revenue are encouraging, while across the river the Copper Basin is attracting much attention.

PRESCOTT. In the Big Bug district the Big Ledge Extension company is to do considerable work on its copper claims. A hoist of 1000-ft. capacity is to be installed.

ARKANSAS

According to J. H. Hand of Yellville, official recorder for the Arkansas Bureau of Mines, northern mines produced 34,086,500 lb. of calamine, 2,562,000 lb. of blende, and 321,000 lb. of lead during 1916. The total is an increase of 144% over that of 1915. The Rush district yielded over 50% of the total; Zinc contributed 15%.

CALIFORNIA

CARRVILLE. The Estabrook dredge at Trinity Center sprang a leak on the night of January 15 and sank in 30 minutes. Efforts will be made to raise the boat, the chances for doing so being considered good, as it was digging in shallow ground. The boat was built in 1911 by the Alta Bert Gold Dredging Co., and had been in commission just five years.

On the 23rd the dredge had been raised and work is being rushed to get it in working order again.

(Special Correspondence.)—The Indian Valley railroad has been completed to Crescent Mills, and the Engels Copper Co. is now shipping from this point instead of Keddie, saving a haul of 11 miles. The line is expected to reach the mine in a few weeks, and it is reported that a branch may be extended into the Genesee district, at present claiming much attention from prominent mining operators. At the Engels property much new work is going on, and plans have been prepared for a 2000-ton flotation plant, of which the first 500-ton unit is scheduled to go into service before July 1.

The International Smelting Co., operating the Walker mine near Portola, has taken under option the Green Ledge and Tutt properties. These mines were worked for their gold ores years ago, and the copper-bearing material neglected. Under the new management the promising copper deposits will be given most attention. Developments at the Walker mine continues satisfactory, despite deep snow. The flotation plant is treating 75 tons of ore daily, and concentrate is shipped to the Tooele smelter of the International company. V. S. Hart is manager.

The U. S. Smelting, Refining & Mining Co. has ordered a large compressor and machine-drills for the Five Bears property, lately taken under bond. The east cross-cut, from a point in the adit about 1300 ft. from the portal, has opened a 15-ft. vein of chalcopyrite. The company is also preparing for comprehensive work at the Iron Dyke, Eagle Hill, and other mines.

The Copper Mountain-Summit group of 36 claims is being developed by H. L. Huston and others of San Francisco. The ore so far opened is chalcocite, with some gold and silver. From the Copper Mountain ore was shipped to Swansea, Wales, in 1864. The Reward and Blue Bell groups, shippers during the Civil War, have been taken under bond by San Francisco people.

The building of the Indian Valley railroad has infused new life into the region, and many old mines have been re-opened,

and numerous prospects are being worked. While the copper deposits claim paramount interest, several gold claims are undergoing development.

Crescent Mills, January 24.

HIGHGRADE. This district in Modoc county attracted a good share of attention in 1912 in both California and Colorado. The district lies on both sides of the California-Oregon State line, and six to seven miles east of Goose Lake valley. The rocks of the region all are volcanic, the ore, which is gold-bearing, occurs in flow-rhyolite and in rhyolite-tuff. Some high-grade ore has been shipped and a large amount of low-grade ore has been developed in the numerous mines. Pyrite and arseno-pyrite are the principal sulphide minerals in the ore, and gold can occasionally be seen. Highgrade is a dis-

HESS MINE, MODOC COUNTY, CALIFORNIA.

trict possessing the elements of success, but by far the greater part of the ore must be treated in reduction plants built at the mines, or at least, in the district, as it is too low-grade for shipment to distant points. Wood and water are obtainable in sufficient amount for both mining and metallurgical purposes, but development has been slow, principally owing to a lack of sufficient capital properly to finance the concerns operating there.

(Special Correspondence.)—Central Eureka shareholders have just received the following report on December operations: Ore treated, 2890 tons, yielding $3239 in bullion and $5180 in 74 tons of concentrates. From sundry sources the company derived $238 and there was collected during the month on account of assessment No. 39, $4,708, making a total of $13,365. The company spent $15,204, of which mining and development work cost $9653; shaft-sinking, $2210; pumping, $364; milling, $1181, while salaries, insurance, attorneys' fees, and sundry expenses make up the remainder. In addition to the shaft work, the 1800-ft. west foot-wall cross-cut was advanced 30 ft., the face now being in mixed quartz and greenstone. Assessment No. 40 of 3c. per share has been levied to meet current expenses, including the installation of a new steel cable.

Sutter Creek, January 23.

COLORADO

ASPEN. This district is watching progress of the Hope tunnel, as it will benefit all in several ways. Mostly local money is in the work. In 1916 the adit was advanced 1200 ft. Indications at present point to ore being near.

BOULDER. The Nederland tungsten area is having a busy winter, with good production. The Primos, Wolf-Tongue, Vasco, Degge-Clark, and Boulder companies are all extracting ore.

CRIPPLE CREEK. It has been decided not to extend the Roosevelt drainage-tunnel to the Golden Cycle shaft, but end it near the shaft of the Portland, which is 1200 ft. ahead.

GEORGETOWN. Ore containing coarse gold has been opened by McCluskey & Convery in their lease in the Capital mine. This is near the rich ore found in September by Hanson & Walthers. Other lessees are doing satisfactorily.

RICO. In the main lower adit of the Rico Argentine, which is in 800 ft., and a depth of 1000 ft., shows 12 ft. of ore assaying 4% copper, 15 to 20 oz. silver, and 15% lead. The zinc-content has disappeared. The shoot has been opened 75 ft., and daily shipments are 25 tons. In the spring an 800-ft. tram is to be constructed, and shipments will be increased to 100 tons.

TELLURIDE. The operating statement of the Colorado-Superior Mining Co., owner of the Black Bear mine, for the fiscal year ended September 30, 1916, shows total receipts from ore sales and boarding-house profit of $259,324, while the total expenses amounted to $191,664. The net operating profit was $67,660. During the period 48,450 tons of dry ore was milled, out of which 3506 oz. of gold bullion, 1888 tons of lead concentrate, and 4660 tons of zinc concentrate were obtained. The total operating cost per ton of ore milled, including development and new construction, was $3.956. Development amounted to 1467 feet.

IDAHO

KELLOGG. In the Pine Creek district the Hilarity and Pine Creek M. & M. companies have been consolidated. This arrangement is of importance, and will result in economic operations.

PORTHILL. The Idaho-Continental mine, which is 26 miles from rail and 3700 ft. higher than the line, shipped 1875 tons of concentrate from August 15 to January 18. About $31,000 net is expected from the sale. The mill is working well, flotation units are to be added, and 1000 tons of concentrate monthly is expected when running full time. Mining is done by caving.

WALLACE. For the sum of $150,000 the transfer of the Frisco mill and concentrator from the Federal Mining & Smelting Co. to the Tamarack & Custer Consolidated Mining Co. was completed on January 16. Besides the concentrator, machinery, water-rights, flumes, penstocks, and right-of-way, the deed conveys approximately 40 acres of the surface ground of various lodes and millsites adjoining the concentrator. The Federal company reserves the ores and minerals beneath the surface and the right to mine and extract the same.

MICHIGAN

HOUGHTON. In spite of cold weather the copper mines in January should make nearly a record output. 'Baby' drills are proving a success in some of the mines, especially in the Ahmeek, which has 35, and the Copper Range mines, which have 135. Calumet & Hecla is trying an improved type of electric-haulage system. The Quincy has completed extracting one of the largest pieces of 'mass' copper ever mined in the district. On No. 70 level the metal was first found, and its length was 78 ft., ranging from 6 to 30 inches in width.

MISSOURI

JOPLIN. Prices for zinc ore rose $11 per ton last week, the range being from $70 to $86. The weather is generally favorable for a steady output. The Missouri-Kansas-Oklahoma region produced 8472 tons of blende, 287 tons of calamine, and 1186 tons of lead, averaging $76, $44, and $90 per ton, respectively. The total value was $766,550.

MONTANA

BUTTE. It is reported at Boston that at a depth of 2800 ft. the Anaconda company has cut ore in the Leonard mine 50 ft. wide, averaging 5%. Part of the vein assays 7% copper, while some of it is as low as 2%. The entire orebody is of commercial grade. Another body being opened on the same level between the Leonard and Tramway mines promises to be equally good and even larger, as at one place it is 150 ft.

wide and at another point 100 ft. This ore averages 3½% copper.

Telegraphic advice states that the Butte & Superior shaft has been damaged by fire, but details are not available yet.

TROY. The Snowstorm Mines Consolidated report for the period April 15 to December 31, 1916, states that the expenditure on construction was $470,548. From $50,000 to $75,000 will be required to complete the work in hand. The new mill is expected to be ready in February.

NEVADA

According to the State mine inspector, A. J. Stimson, there were 5800 men employed in Nevada mines last year. White Pine county leads with 1213 men, Nye second with 1072, Churchill 235, Clark 494, Douglas 4, Elko 380, Esmeralda 767, Eureka 55, Humboldt 294, Lander 127, Lincoln 168, Lyon 264, Mineral 428, Storey 235, and Washoe 64. There were 29 fatalities.

(Special Correspondence.)—The Charleston Hill property has been taken under an eight-year lease by Clark & Clough of Butte, and preparations outlined for the sinking of a shaft at the north end. This is on ground adjoining the National mine.

At the National group, sinking in the foot-wall of the National vein is proceeding, and within 60 days a cross-cut will be started to open the orebody at considerable depth below the present workings.

A lease has been taken on the Chee Foo lode by N. P. R. Hatch, president of the well-known Hatch lease in the Buckskin district. The Chee Foo vein passes through Auto hill, where the first high-grade ore of this place was found, and is well defined. Silver predominates. It is the intention of the Hatch people to sink on the vein.

Work has been resumed on the Last Chance, White Rock, and Equator properties. A large interest in the Equator has been secured by J. S. Miller of Butte, and vigorous developments decided on. At the White Rock, J. L. Workman has started driving of the adit an additional 100 ft. on the Wheeler-Murphy vein.

National, January 25.

(Special Correspondence.)—The first sulphide ore to be found in the Rand district has been encountered at a depth of 320 ft. in the Queen Regent mine. The ore contains copper, gold, and silver, occurring in a contact of andesite and rhyolite. The company is opening free-milling ore of good grade near this point.

The shaft of the Nevada Rand Mines Co. is being sunk a depth of 500 ft.; it is now down 300 ft. The property was recently inspected by C. R. Murdock. Philadelphia people are largely interested.

Much new work is going forward in the Gold Pen. At a depth of 260 ft., the bottom level, the vein is 36 ft. wide with a 5-ft. shoot averaging $19 gold per ton. A 4-ft. vein of $50 ore was lately found in the western part of the mine, and is being developed.

Rand, January 25.

ROCHESTER. It has been officially announced that L. A. Friedman has acquired 71 claims from 54 people, covering the whole vein system of the district, between the Rochester Mines and Nevada Packard properties. The cost was $350,000, for over 800 acres. A 600-ton mill is proposed. The Rochester Combined Mines Co. has been formed to operate the ground. J. W. Wilkey is to be superintendent.

THOMSON. Owing to slow delivery of coke the Mason Valley smelter's start is being delayed. To prevent interruption to smelting, 2000 tons of coke is to be accumulated. Two furnaces will reduce 1000 tons daily, which should benefit the region considerably.

TONOPAH. Last week's output from the district was 9266 tons valued at $166,788.—The Belmont shipped 138,886 oz. of bullion worth nearly $1 per oz. During December the Extension treated 8203 tons of ore for 142,510 oz. bullion, and a profit of $51,220.——Good progress is reported on No. 6 and 7 levels of the Jim Butler.

NEW MEXICO

(Special Correspondence.)—The last two weeks' clean-up on the Mogollon Mines Co. amounted to 15,226 oz. of bullion and three tons of concentrate, from 2450 tons of ore. Ore-pockets are being completed on the 900-ft. level, and regular production will be handled through the new three-compartment shaft by the last of January.

A contract has been let by the Oaks Company at the McKinley in its main adit in Mineral creek. This is opening the Queen vein at the lowest point along several miles of strong outcrops. A larger amount of development is now being done on the Queen at various places than at any time.

During the past two weeks work in the Gold Dust has included cross-cuts into the foot-wall at two or more places, and the vein is shown to be wider than at first supposed. This development is in the main adit, now in over 1000 feet.

Mogollon, January 16.

SANTA RITA. 'Prospecting and Mining of Copper Ore at Santa Rita, New Mexico,' is the title of Bulletin 107, just issued by the U. S. Bureau of Mines, in co-operation with the U. S. Geological Survey. This bulletin describes the situation and general geography of the Santa Rita district, the ore deposits, the adaptation of mining methods to geology and topography, prospecting and locating orebodies, churn-drilling and sampling, assay-records and ore classifications, and the general methods of mining in this district, by the Chino Copper Co. The authors are Donald F. MacDonald and Charles Enzian.

TEXAS

The U. S. Geological Survey is continuing the exploration for potash by drilling in north-western Texas, in the saline deposits of the red-bed formations. This project has been under consideration from the beginning of the potash investigations, and data bearing on the distribution and character of the red-bed salines have been gradually accumulated. On the suspension of the Survey's drilling operations in the Nevada desert basins in the fall of 1915, the equipment was at once moved to Texas and a start made on the boring there. The site of this boring is in Potter county at Cliffside, a minor station on the Fort Worth & Denver City Railroad, 6 miles north-west of Amarillo. The equipment was delivered in November and drilling commenced December 16, 1915. This work was carried on continuously until February 29, 1915, when, owing to the practical exhaustion of the drilling fund, it had to be stopped. The well was then 363 ft. deep. The upper part was cased with 168 ft. of 10-in. pipe, and the lower part was a 6-in. hole without casing. In July, 1916, the new appropriation for Geological Survey work made funds available to carry on the drilling, and steps were at once taken to resume. At this time, however, steel and machinery plants were overloaded with orders, and delay in the delivery of necessary equipment prevented starting the work until November. Since November 7 the work has gone on continuously. Most of the time has been consumed in re-drilling the hole where it had caved below the casing formerly set, and in underreaming and setting a new string of 8-in. casing to the original depth of the hole, 363 ft. On January 1, 1917, drilling in new ground had reached a depth of 386 feet.

(Special Correspondence.)—The West Texas Graphite Co. has been placed in the hands of receiver by Judge Duval West of the Federal District Court at Austin upon application of Albert C. Burrage and Ralph Arnold. Walter Bremond of Austin was appointed receiver. The company is composed of Californians. It began the development of a large deposit of graphite near Burnet, 30 miles from Austin, about a year ago,

and has expended more than $50,000 in plant, etc. The company recently made its first shipment of a carload of the graphite and is now prepared, it is said, to ship regularly. Its inability to meet quickly maturing indebtedness brought about the receivership.

Austin, January 20.

El Paso. Records of the U. S. custom house here for 1916 show that a total of $2,389,459 of gold and silver ores and bullion and lead, zinc, and copper ores were exported from Mexico through this 'port' of entry. This was a falling off of nearly 50% in the value of metals shipped into the United States through El Paso as compared with 1915. There was an increase in 1916 of 6585 tons of lead ore, worth $64,574, over the exports of ore for the preceding year.

UTAH

The State School of Mines, the Utah Conservation Commission, and the Utah Chapter of the American Mining Congress, in co-operation with the U. S. Bureau of Mines, have joined in a plan to locate, classify, record, and develop the mineral resources of the State by collecting all possible information, making free determinations of certain mineral specimens, giving elementary instruction in prospecting and mining, and maintaining a register of prospectors and mining men to bring them in touch with prospective investors. The plan, which is the result of several months' careful study and preparation, is outlined in a joint bulletin issued by the organizations interested. The following information in regard to the deposit from which the samples are taken is desired and should be given in the letters, if possible. Answers to the following will be held as strictly confidential: (1) situation: direction and distance from the nearest post-office, also the nearest railroad. (2) Size of deposit: estimates as to the amount of the material available. (3) Character of the country in which the deposit is situated, that is, whether mountainous, hilly, etc. Is water available? Also timber? (4) Are the specimens especially selected or do they represent the average of the deposit?

Alta. Last week this district shipped 720 tons of ore to smelters. The principal producers were the South Hecla and Michigan-Utah, also the Emma Consolidated.

Tintic. According to J. C. Dick, manager of the Lower Mammoth, most of the work is being done at a depth of 1000 and 1500 ft., where results have been fair in opening copper, silver-lead, and zinc ores.

CANADA

British Columbia

Ainsworth. The new 300-ton mill of the Florence Silver Mining Co., two miles away, is almost ready for ore treatment. In preparing its mine for production the company has spent $350,000. Above the second level there is 200,000 tons of ore ready for extraction. The plant consists of sorting-belts, jaw-crushers, rolls, Snyder sampler, Dorr thickener, tube-mill, trommels, jigs, and Deister tables. A concentrate containing 65% lead and 30 oz. silver is to be made, also zinc concentrate as a by-product. The mill building has been well constructed. It is connected with the mine by aerial tram. The hydro-electric plant generates 350 horse-power.

The Standard Silver-Lead mine is to be prospected by diamond-drilling. The ore in this mine occurs as short lenses, there being a number of them, instead of large shoots as in the Coeur d'Alene of Idaho.

Ontario

During 1916 the Dome mine produced 1,405,900 tons of ore yielding $1,960,888. Dividends absorbed $1,200,000. Costs ranged from $2.40 to $2.88 per ton.

Yukon

Mayo. This district is reported to be busy. A number of prospectors are working on silver claims. The Mayo Dredging Co. is constructing a dredge on Highet creek.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

Percy Williams is at Prescott, Arizona,

S. J. Speak has gone from London to Siberia.

Edgar A. Collins is on a visit to Globe, Arizona.

G. A. Joslin is now with O. J. Salisbury at Salt Lake City.

Frank D. Adams is president of the Geological Society of America.

R. E. Vanruff is in southern Texas making an examination of oil-land.

J. R. Finlay is visiting Globe and Jerome, Arizona, and is expected here in March.

George E. Kubale, recently at the Panuco mines, in Sinaloa, has left Mexico and is in San Francisco.

E. W. Mills and John F. Manning sailed by the *Tenyo Maru* for Japan, going thence to Shanghai, on January 26.

John T. Reid will be at New York for two or three weeks after February 15 before returning to Lovelock, Nevada.

J. H. Lewis, formerly with the Nevada Consolidated Copper Co., is now on the staff of the Braden mine, in Chile.

E. Coppée Thurston is with the smelting department of the Bunker Hill & Sullivan Mining Co., in San Francisco.

Earl C. Stevens, of Portland, Oregon, has recently been examining placer properties in the southern part of the State.

Albert Burch has resigned as local manager for Bewick, Moreing & Co. and as manager of the Plymouth Consolidated Company.

Allan H. Rogers, of Boston, is accompanying W. J. Loring in a tour of inspection in Tuolumne and Amador counties, California.

W. J. Loring, having established himself in San Francisco, has assumed charge of all the Bewick, Moreing & Co. business in California.

O. H. Reinholt has been appointed consulting engineer of the Hecla and Octo Mining Co. at Lordsburg, N. M., and also manager of the New Dominion Copper Co. at Globe, Arizona.

John Woods Beckman and Herbert Emil Linden, with offices in the Balboa building, San Francisco, announce the formation of the Beckman & Linden Engineering Corporation.

C. W. Purington writes to say that the Harvard Club in London is anxious to receive contributions to its War Relief Fund. The secretary of the club is Robert Grant, of Lee, Higginson & Co., at 80 Lombard St., E. C.

William A. Cattell, Henry S. Howard, and Raymond Ashton, announce their association under the firm-name of Cattell, Howard & Ashton, and are prepared to undertake general engineering work, with offices at 68 Post St., San Francisco.

R. K. Stockwell, who has been chief engineer and superintendent of construction for the Braden Copper Co., Chile, for the past five years, will soon open an engineering and sales office at Salt Lake City as representative for the Robins Conveying Belt Company.

Alexander M. Hay, prominent in Canadian mining circles, died from pneumonia at Haileybury, Ontario, on January 20, in his 57th year. He was born in Scotland and came to America as a young man. After operating in the United States, Mexico, and Canada, in 1905 he became interested in the Cobalt district, later at Porcupine.

The A. I. M. E. meeting at New York, commencing on February 19, will extend over four days. The first session will include papers on geology, metallography, petroleum and gas, and milling and smelting; second, on iron blast-furnace practice and flotation; and third, on the manufacture of iron and steel. Interesting trips to works will be made.

THE METAL MARKET

METAL PRICES

San Francisco, January 30.

Antimony, cents per pound	12
Electrolytic copper, cents per pound	35
Pig lead, cents per pound	8.25— 9.25
Platinum, soft and hard metal, per ounce	$85—91
Quicksilver, per flask of 75 lb	$85
Spelter, cents per pound	13
Tin, cents per pound	45
Zinc-dust, cents per pound	18

ORE PRICES

San Francisco, January 30.

Antimony, 50% metal, per unit	$1.00
Chrome, 40% and over, f.o.b. cars California, per ton.	15.00
Magnesite, crude, per ton	8.00—10.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO_3 per unit	17.50—18.00

Molybdenite: The market ranges from $1.70 to $1.90 per lb. MoS_2 contained.

Tungsten ores had not fluctuated greatly within the past ten years until after the beginning of the War. Since then the range of prices has been great, running from an average price of $7.30 per unit in 1914 to $85 in February 1916. Following are the average prices for the past eleven years:

Year	Price per unit WO_3	Year	Price per unit WO_3
1906	$6.30	1912	$6.30
1907	9.05	1913	7.30
1908	5.70	1914	7.30
1909	6.30	1915	15.40
1910	7.30	1916	23.00
1911	5.95	Present price	$17.50-18.00

EASTERN METAL MARKET

(By wire from New York.)

January 30.—Copper is strong at nominal prices. Lead is scarce; trust (A. S. & R.) prices are higher. Spelter is advancing with sellers reluctant to do business.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Jan. 24	76.50	Dec. 19	76.35
" 25	76.50	" 26	76.05
" 26	77.00	Jan. 2	75.37
" 27	77.00	" 9	75.28
" 28 Sunday		" 16	74.66
" 29	76.62	" 23	75.87
" 30	76.62	" 30	75.87

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	57.58	48.85	56.76	July	54.90	47.52	63.06
Feb.	57.53	48.45	56.74	Aug.	54.35	47.11	66.07
Mch.	58.01	50.61	57.89	Sept.	53.75	48.77	68.51
Apr.	58.52	50.25	64.37	Oct.	51.12	49.40	67.86
May	58.21	49.87	74.27	Nov.	49.12	51.88	71.60
June	56.43	49.03	65.04	Dec.	49.27	55.34	75.70

January 23 there was shipped from San Francisco to China about 484,000 oz. of silver valued at approximately $363,000. Later on in the week about the same quantity also went to China.

The Tonopah Mining company paid $150,000 on January 20. This company has bullion stored to the amount of 862,022 oz., worth at 50c. per oz., $431,011.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Jan. 24	31.00	Dec. 19	34.04
" 25	31.50	" 26	31.55
" 26	32.00	Jan. 2	29.90
" 27	32.25	" 9	28.20
" 28 Sunday		" 16	28.33
" 29	32.25	" 23	29.34
" 30	32.50	" 30	31.91

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	14.21	13.60	24.30	July	13.26	19.09	25.66
Feb.	14.46	14.38	26.62	Aug.	12.34	17.27	27.03
Mch.	14.11	14.80	26.65	Sept.	12.02	17.69	28.28
Apr.	14.19	16.64	28.02	Oct.	11.10	17.90	28.50
May	13.97	18.71	29.02	Nov.	11.75	18.88	31.95
June	13.60	19.75	27.47	Dec.	12.75	20.67	32.89

The Calumet & Arizona Mining Co. has declared a quarterly dividend of $2 a share, and an extra of $1 a share, payable March 19. Similar dividends were paid by this company in December.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Jan. 24	7.75	Dec. 19	7.69
" 25	8.00	" 26	7.50
" 26	8.00	Jan. 2	7.49
" 27	8.00	" 9	7.50
" 28 Sunday		" 16	7.50
" 29	8.12	" 23	7.72
" 30	8.25	" 30	8.02

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	4.11	3.73	5.95	July	3.80	5.59	6.40
Feb.	4.02	3.83	6.23	Aug.	3.86	4.67	6.28
Mch.	3.94	4.04	7.26	Sept.	3.82	4.62	6.86
Apr.	3.86	4.21	7.70	Oct.	3.60	4.62	7.02
May	3.90	4.24	7.38	Nov.	3.68	5.15	7.07
June	3.90	5.75	6.88	Dec.	3.80	5.34	7.55

The Caledonia Mining company declared its regular monthly dividend of $78,150, payable February 5. This makes a total of dividends by this company of $1,950,781.

The Hecla Mining company on January 20 paid dividend No. 164, amounting to $150,000, making the total paid by this company $5,455,000.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Jan. 24	10.12	Dec. 19	11.13
" 25	10.12	" 26	10.00
" 26	10.25	Jan. 2	9.75
" 27	10.50	" 9	9.66
" 28 Sunday		" 16	9.37
" 29	10.50	" 23	10.00
" 30	11.00	" 30	10.41

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	5.14	6.30	18.21	July	4.75	20.54	9.90
Feb.	5.22	9.05	19.99	Aug.	4.75	14.17	9.03
Mch.	5.12	8.40	18.40	Sept.	5.16	14.14	9.18
Apr.	4.98	9.78	18.62	Oct.	4.75	14.05	9.92
May	4.91	17.03	16.01	Nov.	5.01	17.20	11.81
June	4.84	22.20	12.85	Dec.	5.40	16.75	11.26

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Date.		Jan. 16	80.00
Jan. 2	80.00	" 23	80.00
" 9	80.00	" 30	85.00

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	39.25	51.90	222.00	July	37.50	95.00	81.20
Feb.	39.00	60.00	295.00	Aug.	80.00	93.75	74.50
Mch.	39.00	78.00	219.00	Sept.	76.25	91.00	75.00
Apr.	38.90	77.50	141.60	Oct.	53.00	92.90	78.20
May	39.00	75.00	90.00	Nov.	55.00	101.50	79.50
June	38.60	90.00	74.70	Dec.	53.10	123.00	80.00

TIN

Prices in New York, in cents per pound.

Monthly averages

	1914.	1915.	1916.		1914.	1915.	1916.
Jan.	37.85	34.40	41.76	July	31.60	37.38	38.37
Feb.	39.76	37.23	42.60	Aug.	50.20	34.37	38.88
Mch.	38.10	48.76	50.50	Sept.	33.10	33.12	36.66
Apr.	36.10	48.25	51.49	Oct.	30.40	33.00	41.10
May	33.29	39.28	49.10	Nov.	33.51	39.50	44.12
June	30.72	40.26	42.07	Dec.	33.60	38.71	42.55

Spot Straits tin was quoted on January 16 at 44.25c. at New York. An advance from 42.50c. was made during the week. Banca was sold on January 10 at 40.25c., for early shipment from the East, and on January 12 at 42c. The best day of the week was January 12, when 150 to 200 tons changed hands. On January 15 inquiry from nearby positions was large, and probably 400 to 500 tons would have changed hands had the metal been available for delivery in four to six weeks. Dealers as well as consumers wanted to buy. Tin is the only metal whose market would be improved by an ending of the War, as peace would bring a wider market. The arrivals this month total 2225 tons, and there is afloat, 3708 tons.

PLATINUM

Price of platinum, New York, is $100 per ounce for soft metal and $106 for hard. Platinum has advanced within the week $10 per ounce for both grades of the metal.

Eastern Metal Market

New York, January 24.

Copper prices are again on the upward trend, and already have reached levels that existed prior to the recent peace agitation. Nearby metal has almost entirely disappeared, and all sellers are looking for another boom. The belief is steadily growing that Great Britain must soon close for an enormous quantity of copper for last-half delivery; in fact, it is said that negotiations are under way.

Zinc is easily obtained, but producers are confident that export buying is not far off. Meanwhile prices continue firm.

The lead situation resembles that in copper. Spot and nearby lead is almost unobtainable at any price, but the scarcity is in large part due to the railroad situation. Large consignments are tied up in transit. Meanwhile the holders of lead are commanding fancy premiums.

Tin has advanced because of uncertainty as to what is being done abroad. The cables are irregular and incomplete.

Antimony is higher, one reason for which is the reported curtailment of production in China.

The steel mills are confronted with a flood of export inquiry, while specifications on domestic account are extremely heavy also. It is noted that while the official quotations of the Steel Corporation are 3c., Pittsburg, for bars, 3.25c. for shapes, and 3.75c. for plates, prompt deliveries of those products would be hard to find at those levels. Business in tank plates is freely done at 5c., Pittsburg; in ship plates at 6c.; in shapes at 3.50c., and 3.25 to 3.50c. for bars.

Eastern Pennsylvania mills assert that they are in receipt of less 'wild-cat' export inquiries, and are pleased thereat. The export demand for steel-making iron, especially Bessemer, continues heavy. One inquiry calls for 100,000 tons, for which $35 per ton is offered. Standard low phosphorus iron has sold at $57 for both domestic and export delivery. The foundry-iron market is quiet, but strong, the eastern Pennsylvania producers asking $30 to $32, furnace, for No. 2. Italy is taking large quantities of materials, her Government having preempted most of the ships that run to her ports for the purpose. She has paid $62.50 per ton for soft-steel billets, and is buying old steel-axles and other scrap to relieve her needs. China wants 400,000 boxes of tin-plate. On all sides, production is restricted by transportation difficulties.

COPPER

Electrolytic copper for first-quarter delivery is practically unobtainable, and prices are much stronger, some interests refusing to quote altogether. It follows that quotations which are given are nominal. The reason for the strength so suddenly displayed is a general belief that the Entente Allies are seeking to place a gigantic order for last-half metal. For some weeks it has been rumored that such an order was to be placed, but the source of the information was close to Wall Street, and it was not accepted by the trade. More recently, however, it became known that negotiations had been initiated, and something may come of them. How difficult it has been to obtain nearby copper in the past few days is exemplified by the case of a manufacturer who tried to get a price and delivery from 13 different sellers, including both producers and second-hands. Not one would give him a figure, all declaring that they were out of the market for the first quarter. Some May and June metal is obtainable in small lots at 29 to 29.50c., while for the third quarter 27.50 to 28c. is asked. Spot is 32 to 33c., and February around 31c. It will therefore be seen that copper prices are not far from the levels from which they dropped following the recent peace talk. Lake is nominally at the same levels as electrolytic. Brass and copper products continue to hold up well, both as to prices and demand. Mixed specifications for brass rods bring forth quotations of about 40c., although a desirable order for heavy rods might be placed at 34 to 35c. In tubes, the situation is worse than ever. With the larger sizes having heavy walls, March shipments are considered good, while with the lighter sizes delivery cannot be had until May. Wide sheet brass is difficult to obtain, but April delivery of 12-in. strips can be had at about 42c., commercial specifications, although it is probable that 37c. would be accepted on a big order. Sheet copper is unchanged at the 42c. base, copper rods being held at the same figure. Exports of copper ingots this month total 18,829 tons. The London quotation for electrolytic, cabled yesterday, was £141. For several days the cables have been irregular, some not arriving at all, others being undated. The Perth Amboy refinery of the A. S. & R. Co. has just settled a strike which has greatly hampered production the past week or ten days.

ZINC

A quiet, waiting, but nevertheless firm, market is all there is to record, but producers' representatives are confident that a turn toward higher prices will come soon. They believe that Great Britain will soon buy, apparently basing their hopes on that nation's consumption of copper. Meanwhile prices have held up well, and yesterday a little added strength was shown. January prime Western was quoted around 9.87½ to 10c., St. Louis, for prompt delivery, with New York at 10 to 10.25c. February was 9.75c., St. Louis, and March 9.50c. Brass-mill special was sold this week for early delivery in central New York at 11c. It commands a premium of 1 to 1½c. over prime Western. The London quotation yesterday was £47. Exports of January 1 to 24 totaled 4367 tons. Sheet zinc is unchanged at 21c., carload lots, f.o.b. mill, 8% off for cash.

LEAD

The situation in lead has closely resembled that in copper. Spot supplies are extremely low, and premiums are easily obtainable. Most of the trouble with lead is traceable to transportation delays, which have held back needed supplies from manufacturers, making it necessary for them to seek relief in the market despite the fact that they might have plenty of lead under contract. For prompt delivery, independent sellers have been readily getting 7.75c., New York, and 7.62½c., St. Louis, and higher. The A. S. & R. Co. continues to quote 7.50c., New York, although it is well understood that it is not selling at this figure, but using it as a basis for computing an average price. It has been reported from day to day that the big producer intends to advance its quotation. Meanwhile the metal is so scarce that a great deal of business has been turned down. The London quotation for spot, as cabled yesterday, is unchanged at £30 10s. Exports from the 1st to 24th were only 937 tons.

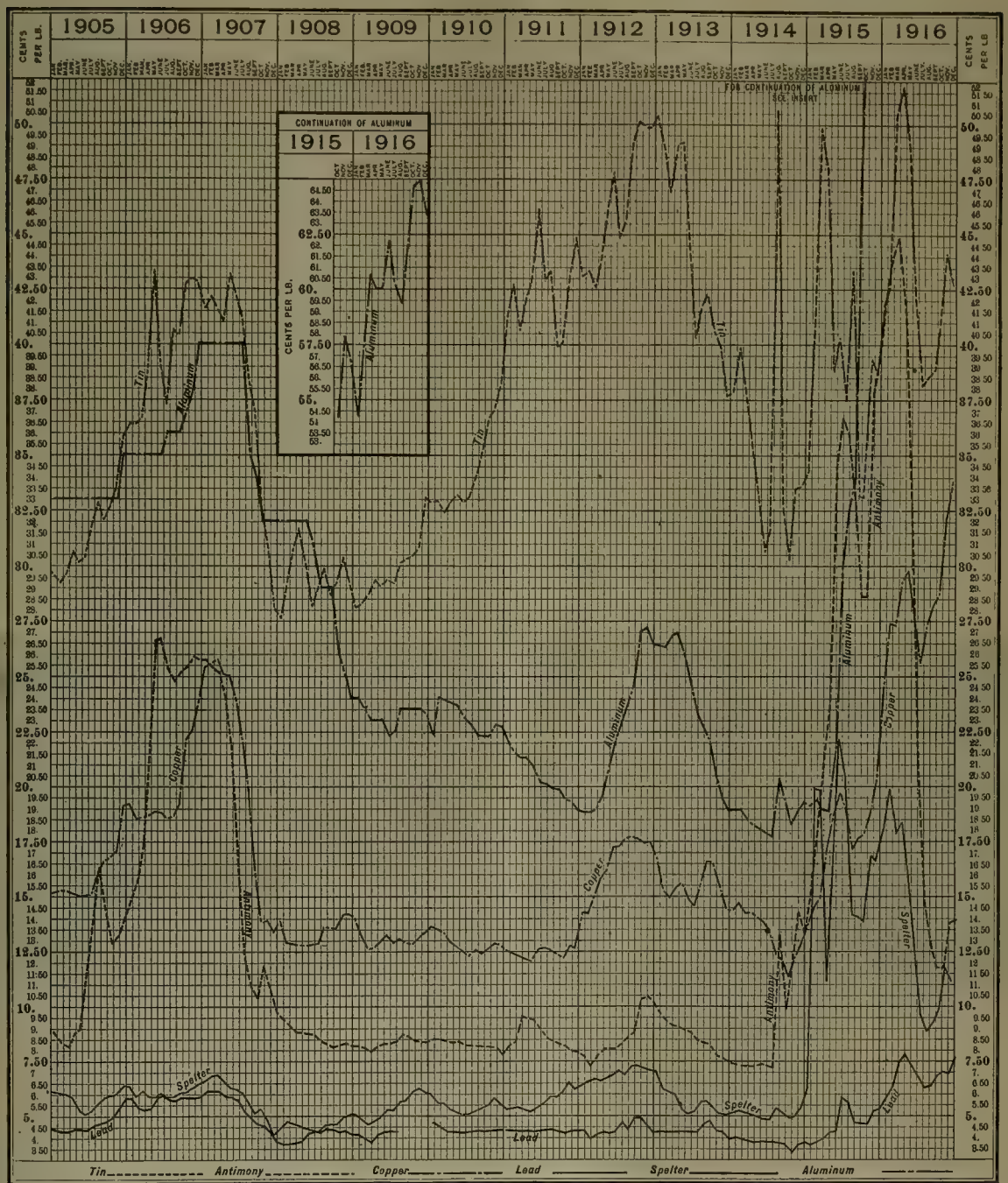
TIN

The quotation for spot Straits yesterday, the 23rd, was 45.50c., New York, with not much offered. Supplies seem to be scarce, but a more potent reason for the higher price is the uncertainty under which both sellers and consumers are working because of the irregular cables from London. For the better part of a week no worth-while cable was received until yesterday. On some days no news came at all, while on others the cables were not dated and consequently of little value. The arrivals this month total 2650 tons and there is afloat 3558 tons. Banca tin is scarce, also, but more generous arrivals are expected.

ALUMINUM

The quotation for No. 1 virgin aluminum, 98 to 99% pure, is easier at 56 to 60 cents.

Twelve Years' Metal Prices



The above chart, prepared by the *Steel and Metal Digest* of New York, was plotted according to the monthly average prices of electrolytic copper, Straits tin, aluminum (98-99%), antimony (Cookson's; prior to August, 1914, Chinese and Japanese thereafter) all New York, and pig lead and prime Western spelter, St. Louis.

Industrial Notes

Information supplied by the manufacturers.

Short-Centre Belt-Drives

One source of power loss is in the slipping of belts, even the best belt-drive involves 2% slip, and some drives 5% or more, which is serious. To overcome this loss it has been customary to use long belts or greater tension to get more traction. Belt-tighteners are forced with great pressure against the belts, and while slippage can be overcome to a certain extent by such means, it more frequently results in excessive bearing pressure, over-heating, etc., and simply consumes the power by friction at the bearings instead of by belt slippage. With the object of keeping down bearing pressure, this condition of

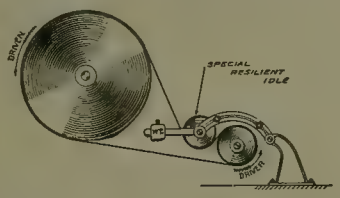


DIAGRAM EXPLAINING PRINCIPLE OF SHORT-CENTRE BELT-DRIVE.

affairs is responsible for the considerable use of silent chain-drives, so as to get sufficient drives at short centres with freedom from slip. But such drives have about reached their limit on account of high first cost, expense of upkeep, and the constant attention they require, together with the fact that the speed of silent chains is limited to about a quarter of what has been found entirely practicable with good belts and pulleys.

On account of the constant tendency toward higher speeds in prime-movers and machines, it was with great interest that the experiments with short-centre belt-drives controlled by yielding idlers, carried on in Europe during the last few years, were watched by the mechanical engineers of this country. The new system involved the use of especially constructed pivoted idlers, mounted on ball or roller bearings, operating against slack belts somewhat in the nature of a belt-tightner, though in principle quite different, as will be explained, and permitted of short centres, at the same time giving greatly increased horse-power with practically no slip. This system was studied by the engineers of the Meese & Gottfried Company of San Francisco, and other Pacific Coast factories, and developed to a high state of mechanical perfection; in fact, this firm is the only one that has gone thoroughly into the engineering of the subject in this part of the country, and though a new undertaking, has already supplied these drives to operate 10,000 hp. The principle can be gathered from the accompanying diagram, and is totally different from a belt-tightener in several important features, as

(1) It does not cause an increase in belt-tension for a given horse-power.

(2) It operates just as satisfactorily on short centres, where formerly a belt-drive would have been impossible.

(3) It does not increase the bearing pressure with consequent over-heating and rapid wear of same.

(4) It makes possible the transmission of almost twice the horse-power heretofore considered practicable with a leather belt.

(5) It is easy on the belt and with a good flexible grade of belting it causes no injury.

On first seeing one of these drives the average mechanic would class it as a swinging-belt tightener drive, but would be in error, as can be seen from its distinctive features enumerated above, for it is not merely a 'device' but is more properly a system, the successful installation of which depends on the proper position of the idler, its effective weight relative to the horse-power and speed of the drive, together with the pre-determined slack in the belt, as the belts are purposely made loose. The angle and direction at which the drive runs must also be considered, as the idler may be controlled by weights on levers arranged at the proper angle, or may be pulled upward or sidewise by ropes and counter-weights. On heavily pulsating loads, pneumatic-shock absorbers are sometimes connected to the oscillating frame to steady it. This new development in short-centre belt driving undoubtedly has a great future, as it accomplishes what can be done by no other means —transmitting from the smallest to the heaviest horse-power smoothly and silently at high efficiency, and at speeds which would be quite impossible with silent chains. Practically all belt-drives from the heaviest main drives down come easily within its scope.

PHOTOGRAPHS OF SHORT-CENTRE BELT-DRIVE INSTALLATION IN OPERATION.

These pictures show a motor running at 700 r.p.m., driving by a 20-in. wide rubber belt a double-acting duplex air-compressor at 140 r.p.m., consuming 150 hp. Note the close centres of pulleys.

The annual convention of the sales and factory organizations of the Chicago Pneumatic Tool Co., was held on the 11th, 12th, and 13th of January. About 100 were present.

ORE TREATMENT PROBLEMS

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JAMES M. HYDE
MINING ENGINEER
MILLS BUILDING

SAN FRANCISCO, CAL.,

February 3, 1917.

To the Mining Fraternity,
United States of America.

GENTLEMEN:

For five years I have been applying my best efforts to establish your right to the use of flotation concentration without the payment of exorbitant royalties.

These efforts have met with a considerable degree of success. The United States Supreme Court has decided that the so-called "basic flotation patent" is limited to the use of less than 1% of oil in combination with such agitation as will beat into the pulp the air necessary to form a "peculiarly coherent and persistent froth."

The alternative, and generally better, process of flotation which consists in introducing air into an oiled pulp through a permeable medium, such as canvas, and thereby forming a peculiarly fragile froth, does not in any way infringe the so-called "basic flotation patent" as defined by the Supreme Court, no matter what amount of oil is used, because this pneumatic process includes neither the "beating in" of air called "agitation" by all of the claims of the patent, nor the formation of a "coherent and persistent froth" which is described by the patentees as a distinguishing feature of their process.

As is well known, this later and better method was fully described in a British patent taken out in 1910 by Theodore J. Hoover and Minerals Separation, Ltd. These patentees did not take out an American patent to cover their invention and thereby presented this process to the citizens of these United States.

I have designed and introduced into successful use the best machine for carrying on the pneumatic flotation process which I have yet seen.

You can buy this improved pneumatic flotation machine direct from me for a flat price just as you buy any other machinery. To meet the present occasion I will supply these machines at $600 per unit. The units have a canvas area of 27 by 135 in., consisting of seven independently adjustable and replaceable air-cells. The capacity of the units will vary from 25 to 100 tons in 24 hours, depending on the class of material treated. With some ores the best results are obtained by using two units set tandem.

This machine is in operation in a number of mills treating mixed sulphide ores. It is pronounced by one of the most experienced superintendents using it as in all ways the most satisfactory ore-dressing machine of any kind that he has ever seen, and he has seen nearly all of them.

I am also prepared to build for your special needs my new fine-classifier and my novel rotary sand-classifier, both of which are proving very useful when used with the flotation machine. Like the latter, they were not designed with the idea of producing machines for sale, but were worked out in an effort to treat more satisfactorily the difficult ores I have been dealing with than could be done with the machinery obtainable on the market.

The fine-classifier is a mechanically efficient combination of hydraulic classification to remove the fines and drag-classifier-dewatering of the slime-free sand. By its use the material of a desired fineness is all removed as a pulp of minimum dilution after each grinding operation. The production of dilute slime pulp necessitating the use of pulp-thickening equipment is thereby avoided. In the mill where this classifier is being used all of the flotation feed is collected from this machine as a pulp so thick that it is diluted with clear water before treatment by flotation. The back-water on the tables treating the sand-sizes is clear enough to drink.

The rotary classifier utilizes the free settling-factor for the division of the sand-pulp into as many classified sand-sizes as desired with the use of no hydraulic columns that require independent adjustment. One of the most experienced operators and inventors of ore-dressing machinery in the country says that he believes this is the best and most positive classifier ever built.

All three of these machines have been perfected in mills where I have run them personally. They fulfill the needs of an operating mill. All you have to do with them when they are properly adjusted is to let them alone. Used together they give the best results and the best balanced plant I have ever seen.

Fraternally yours,

James M. Hyde

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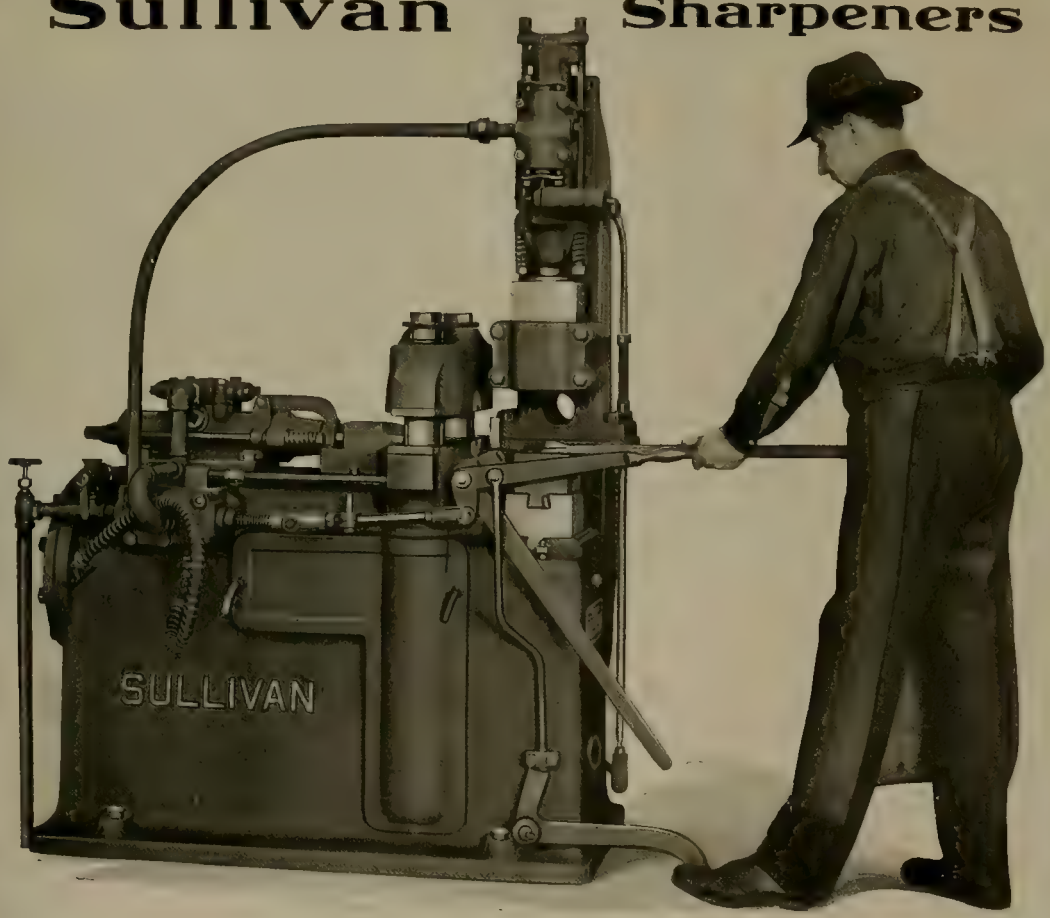

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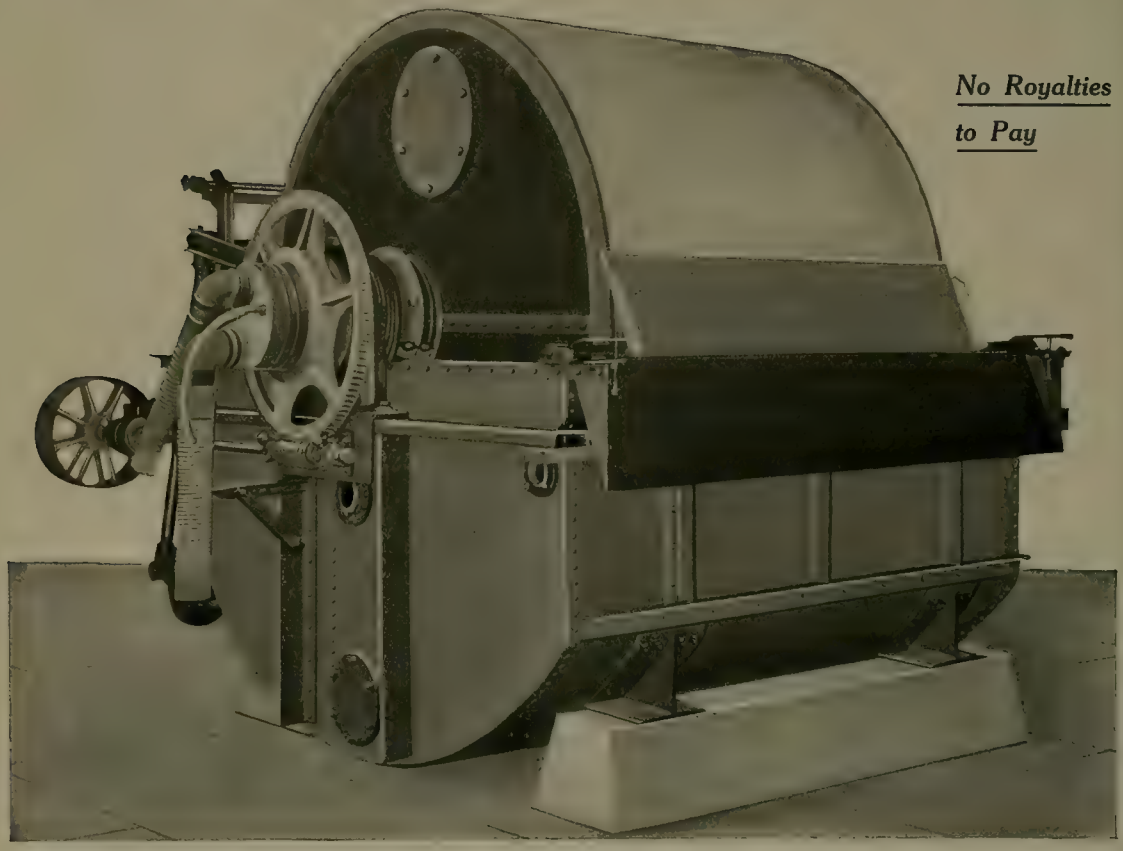

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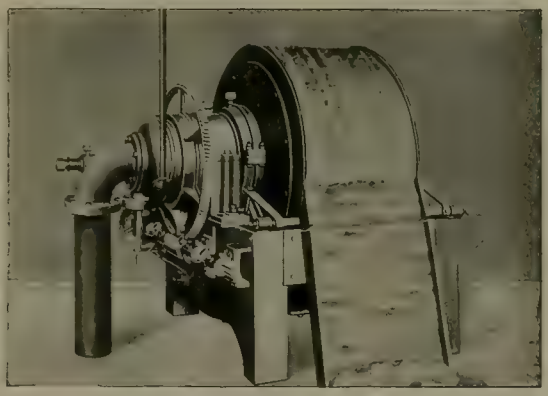

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The Union Construction Page

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TO MINERS
of
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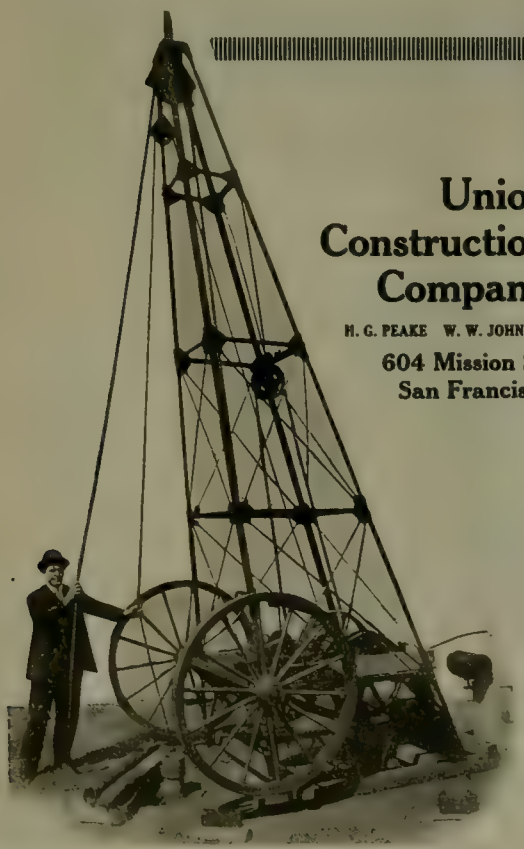
Investigate the Union Drill. It is easy to operate; it is readily portable and can be knocked down for mule-back transportation and easily re-assembled. It is made in two types, A and B, the latter with steel frame and design for somewhat heavier work than A. The illustration below shows the Type B drill ready for operation. Bulletin 15 gives much interesting data of value to prospectors and placer miners in general. Write for it.

This is one of many gold dredges designed and constructed by this company. It was built for C. J. Berry and has a 3½-foot bucket line, and digs from 1700 to 2400 cubic yards per day of 24 hours. We contract for the design and construction of gold dredges for any capacity, to be erected anywhere. This dredge is operated on wood fuel, using only $3\frac{4}{10}$ cords per day of 24 hours.



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EDITORIAL

T. A. RICKARD, Editor

WHY not make froth in a cyanide solution and kill two birds with one stone?

IMMIGRATION improved in 1916, the total of incoming passengers at New York, for example, being 259,367 as compared with 216,274 in 1915. But in 1913 the arrivals numbered 1,332,200. These statistics are important in their relation to the supply of labor.

GOLD output of the Transvaal in 1916 is stated at $197,424,670, or $12,873,365 more than in 1915. The yield of the Indian mines, in the Kolar goldfield, declined to 541,077 ounces, as compared with 556,596 in 1915 and 602,006 ounces in 1914. The West African and Australian productions also exhibit a decrease.

CANADA now can obtain all the lead, copper, and zinc that is needed for industrial purposes from the refinery at Trail, so says the annual report issued by the Consolidated Mining & Smelting Company of Canada. While the copper production of British Columbia is more than enough for Canadian needs, it is not refined in Canada. The domestic refinery at Trail is an establishment of which the Dominion has reason to be proud.

WE never thought so much of the Rocky Mountain Club as when it set aside the $500,000 pledged for a new house and gave this money to the Belgian Relief Fund. Mr. W. B. Thompson set a fine example by subscribing $100,000. There should be many more in the club willing, as there are many more able, to do likewise—for example, Mr. Bernard Baruch, who testified at the 'leak' inquiry that he made $476,178 during the peace scare.

IN the midst of bigger events the Mexican episode is overlooked. Another vera-crusade is ended and General Pershing's expeditionary force has been withdrawn. Villa, whom the expedition was meant to kill or capture, is still on the rampage, stronger than before. However, the withdrawal of the American troops will serve to strengthen Carranza rather than Villa, robbing the latter of the claim that he is the object of foreign incursion. The pacification of Mexico will have to wait on the conclusion of the larger affair in Europe.

WHAT is happening in Mexico is suggested by the events at Panuco, in Sinaloa, where the Carranzista people seized an important mine and removed the pillars of ore left to support the workings; they did no development work but simply 'gutted' the mine. Operations were directed, for the pseudo-government, by Villalobos, a vaudeville singer. The Spanish-Mexican company owning the property has claimed $2,000,000 as indemnity. The product of the mine is a simple silver ore becoming coppery in depth. By cyanidation the best extraction is only 55%, whereas flotation gives a high recovery. The high cost of cyanide will give the new process an opportunity to establish itself.

WE publish an article on mining of the precious metals in the Chinese province of Chihli, by Messrs. A. S. Wheler and S. Y. Li. Mr. Wheler has recently resigned from the post of Inspector General of Mines to the Chinese government. He is one of several capable men that have tried to help the Chinese in framing workable regulations for their mining industry, but without success. Messrs. Wallace Broad and G. G. S. Lindsey are among the others that engaged themselves in this Sisyphean task.

ORE does not persist indefinitely in depth, but rarely it will continue downward farther than expert opinion anticipates. Thus 5% copper ore, 50 feet wide, has been cut at 2800 feet deep in the Leonard mine at Butte. At one time the hypothesis of secondary enrichment by chalcocite precipitated from descending solutions caused engineers to expect non-persistence in depth —and by 'depth' at Butte was meant 2000 feet or even less. The primary origin of the Butte chalcocite from ascending solutions is now at least as well substantiated as the less cheerful hypothesis.

DURING the two past calendar years the net inward flow of gold into the United States has been $950,000,000, as against a net outward movement of $193,000,000 in the two preceding years. In the one month of December the gold imports were $158,000,000. During the last 24 months this country has lent $2,400,000,000 abroad and bought back its own securities to even greater value. The trade balance for the 29 months of the War has been nearly equal to the value of the exports during the previous similar period. In 1916 we sold goods at the rate of $54.81 worth for each inhabitant of the United States.

KENNECOTT COPPER is still being puffed by the *Boston News Bureau*. We understand that there really was some serious talk about a consolidation of the Kennecott, Chile, and Utah copper companies, but a vigorous protest was made by the mining men that hold

large blocks of Utah Copper. It is recognized by them that there is no valid economic reason for the further consolidation, creating a monstrous enterprise with widely scattered interests. Such a scheme would offer chances for financial legerdemain, that is all. Utah Copper, owing to its interior position, is safe from the effects of naval warfare and owing to its employment of high-priced skilled workers it is not likely to suffer from labor troubles. Well managed, well organized, and based on splendid reserves of ore, the Utah Copper enterprise would gain nothing by falling into the maw of the Guggenheim agglomeration.

MUCH of the preparedness talk is like that of the old woman that stepped off a moving car backward shrieking 'safety first.' The Secretary of the Navy has stated that the manufacturers bidding for the construction of four battle-ships demanded a 35% margin of profit, amounting to $5,000,000. When an appeal was made to the bidders to reduce their bids on patriotic grounds, only one acquiesced—and that one, the Bethlehem Steel Corporation "for self-advertising purposes, made public its decision to lower the price 10% as a patriotic service to the United States." The company still made 25% profit. It is no wonder that a Government steel manufactory is under discussion.

AMONG the consequences of the War we may mention a depreciation of $4,610,000,000 in the aggregate market-value of 387 representative securities quoted in London. In 1916 the net loss was $745,000,000, the biggest drop having taken place in the ten days preceding the declarations of War—July 20 to July 30, 1914—when the loss was $2,830,000,000. On the other hand the rise in the price of shipping is equally astounding. The steamer *Hercules,* which was sold for $425,000 in 1915, brought $1,300,000 in 1916, although in 1904 she changed hands for $161,250. The *Askelad* sold for $692,500 in 1916 and for $72,500 in 1912. The *Demetrios Inglesis,* which sold for $400,000 in 1916, was worth only $35,000 five years earlier. Sailing-ships likewise have sold for 10 and 15 times their pre-War valuation. It's an ill wind that blows no one good.

SOME mineralogial names are deceptive; for example, molybdenite is molybdenum sulphide; molybdomenite contains no molybdenum, but is lead selenite. Copperas includes no copper, but is the sulphate of iron. Limonite is brown iron oxide and contains no lime. Argentine is a pearly lamellar variety of calcium carbonate, or calcite; whereas argentite is black silver sulphide. Black-lead is a common name for the amorphous form of carbon technically known as graphite. It contains no lead. Chloride and chlorite are as far apart in composition as are quartz and limestone. Glaucophane is a blue variety of hornblende, and glauconite is a green scaly iron silicate. Chrysolite, or olivine, also known as peridot, is a silicate of iron and magnesium; and chrysotile is a magnesium silicate, a fine, silky cross-fibred variety of asbestos. Soapstone feels unctuous and soapy to the touch but it is destitute of soap. Wolframite is iron-manganese tungstate; wulfenite is lead molybdate, yet the two are often confused. Chalcodite is a bronze-colored iron silicate of velvety appearance with a micaceous structure, and chalcocite is copper sulphide. Cyanite is an aluminum silicate and bears no relation to cyanide nor to the rock syenite. Pitchblende is a uranium oxide and contains no pitch, though resembling it in appearance, nor is it related to zinc-blende.

IN these days we hear much concerning an international tribunal that is to be created at the end of this war in order to put an end to war. Perhaps those of us that desire greatly to see Mexico pacified will have to wait for that embodiment of peaceful sentiment in order to put a quietus on the 'istas rampaging south of the Rio Grande. In his latest article Mr. H. G. Wells says: "This International Tribunal, if it was indeed to prevent war, would need also to have power to intervene in the affairs of any country or region in a state of open and manifest disorder, for the protection of foreign travelers and of persons and interests localized in that country, but foreign to it." That seems to cock an eye at Mexico. Well, if no one else will do it, let it be the International Tribunal and if it does it we shall not grudge the capitals.

NEVER were we so proud of our craft as when we heard it said, at the dinner given by the Friends of France to the 21 Stanford students that had volunteered for Red Cross work, that their enthusiasm for this service had been aroused by the editors of college periodicals. Moreover, it was stated that several of those volunteering for this noble work had given up chances of being editors of the University press, and this was deemed a real sacrifice. Evidently the young editors are able to create opinion of a worthy kind and willing to live up to it themselves—which is exactly what our local daily press fails to do. The young men about to go to France in a humane endeavor to lessen suffering and to save life are a credit to the State. Stanford has won imperishable renown for the work done by her sons in Belgium and the Red Cross in France. A university indeed! if a seat of learning cannot evoke the generous sentiment of youth and if it is unable to express its high ideals by personal service, it is a poor sort of university.

DISCUSSION this week includes a number of interesting letters. Mr. John F. McLennan writes concerning the distribution of ore as affected by faults. He offers a reasonable explanation for the localization of rich ore between the surface and a fault-plane that acts as a barrier to the descent of solutions enriched by weathering. Further contributions on this subject will be welcome. Mr. Horace V. Winchell replies to some comments of our own and criticizes them in a manner to which no objection can be taken. We would like our readers to believe that criticism of editorial remarks is

always welcomed by us, because we are fully aware of the fact that such criticism is usually more interesting than the expression of a polite agreement or a flattering concurrence. Another letter on the revision of the mining law comes from Mr. A. E. Robinson, who discusses sundry changes recently proposed. He keeps the prospector in mind, as we think he should, and objects to the proposal to locate square claims along lines following arbitrary courses. He also protests against the substitution of money payment for assessment work, and in this he is likely to voice general sentiment in our mining districts. Mr. A. E. Drucker, who returned recently from Colombia to New York, offers some timely remarks on ball-mills. He refers to a controversy conducted in the pages of *The Mining Magazine*—of which controversy we beg to say that it was not in the least convincing because it was conducted for the most part by gentlemen in the employ of the manufacturers of the machines discussed. To Mr. Lucien Eaton, superintendent of the Cleveland-Cliffs iron mine, we are indebted for his answers to the pertinent questions propounded by A. B. C. in our issue of January 13. The information given by Mr. Eaton will be appreciated by many of our readers and may provoke some of them also to try a hand at the catechism submitted by the anonymous seeker after knowledge. The letter from a lady finds acknowledgment in an editorial foot-note. Speaking of Belgian Relief, we dislike to think of the effect of recent events on the labors of the Commission and hope that Mr. Hoover will be able to proceed with his good work even though the shadow of war be further darkened over its first unhappy victims. Mr. W. A. Freeman, recently arrived from Sydney, gives an interesting bit of information concerning the taxing of mines in Australia. He and his friends, who are operating a tin mine in Bolivia, propose to incorporate a company in California, mainly to protect themselves against excessive taxation in Australia. The registering of another of their companies in the Malay States serves likewise to draw attention to the effects of war taxation on the mining business.

On the Edge

At this time of writing the United States is still at peace, but an act that would compel a declaration of war against Germany may follow at any moment. The rupture of diplomatic relations with the most aggressive of the belligerents in Europe is an event that cannot fail to make an emotional appeal to every thoughtful man and woman in the country, and all the more because it has come after a long period of patience. Good reasons for giving Count von Bernstorff his passports were afforded, in the opinion of many, at a much earlier date and if drastic action has been taken now it is due to the logic of the position into which the negotiations arising from the indiscriminate destructiveness of the German submarines has forced the Government of the United States. The German note of January 31 called inevitably for the response made by the President on February 3. The German pronouncement expressed a policy of sheer desperation and a determination to fight without regard for any of the few remaining rules of the game that survive the welter of savage warfare. It flouts the opinion of the world and at last places the chief neutral in a position where further inaction would be stultifying. The President has justified his policy and disarmed his critics whether among his own people or abroad. After an exhibition of patience and long-suffering that has evoked the jibes of his political opponents and the hardly disguised satire of foreigners, he has risen to the occasion in a manner and with a spirit that must arouse not only the enthusiastic support of every American, but also the cordial admiration of the other neutral nations. The moral effect of his action will be all the greater on account of his forbearance, and the Government of the United States will be enormously strengthened thereby in any later effort to promote the lasting peace of the world. The break with Germany is based on clearly legal grounds. It is the sequel to an unequivocal declaration of the American intention to uphold "the sacred and undisputable rules of international law and the universally recognized dictates of humanity." Unless we had made up our minds to stand aside and see the world sink into a veritable slough of barbaric reprisals, we were bound to take the action that the President has taken for us as a people. He has done it promptly and with all the impressiveness that the occasion demands. It remains for every good citizen to exercise self-control. Those that are of European origin or still retain European ties, of sentiment or blood, will now prove their loyalty to the country of their adoption by showing sympathy for the many citizens of German origin to whom this crisis must be soul-harrowing. From the searching of spirit that must follow the break of friendly relations with Germany, and probably with her allies also—not to mention the possibly graver event—there will come a filtering if not a fusion that will do more to unify the American people than all the Fourth of July orations that were ever made. We believe confidently that the mental detachment, verging on vacuous aloofness, that has marked a large part of our people, especially in the West, during the last two and a half years will now be submerged by eager interest in the history-making events of the hour and that the call to loyalty will fuse the discordant elements in our population, kept apart alike by European antagonisms and by the official dictum of neutrality. Even the most pacific of men must have noted the disintegrating effect of the War on our people so long as it appealed to them variously and at different angles, but now the clear stand taken by the President, with the full support of Congress, in behalf of international law, will make us one—a nation indeed, united in resolute defence of the right to live and let live, of those conventions of conduct upon which civilization rests, of those sanctities of international justice without which man might as well return to the ape and tiger existence of the jungle.

Subsidence at Treadwell

In this issue we publish an abstract from a recent report on the dangerous condition of the Treadwell mines. Our readers will recall that the consolidation of this group of properties on Douglas island, Alaska, was recommended by Messrs. H. C. Perkins, Hennen Jennings, and F. W. Bradley in a report dated July 31, 1916, the more important part of which was published, with editorial comment, in our issue of August 26, 1916. In that report the three distinguished engineers endorsed the resident manager's estimate that only 7,010,000 tons out of the 15,678,600 tons of ore assumed to be blocked-out could be saved owing to the caved condition of the mines. The loss of ore supposed to be in reserve was an important feature of that investigation, although it was not emphasized. However, in the concluding paragraphs of the report a proper stress was laid on the seriousness of the caving, which was used as an argument for advocating common control and concerted action by this group of mining companies. Moreover, in the appendix, Mr. H. G. Wayland, the general superintendent, stated frankly that if the caving extended to certain vital points, notably the Central shaft, it would entail such a loss of ore as to reduce the estimated profit in the developed ground of the Treadwell and 700-Foot mines to "a nominal figure." The development of dangerous lines of weakness in the Mexican mine was also described. In the later report by Mr. F. W. Bradley, the president of the consolidated companies, it is made clear how serious is the condition of the workings. The caving of the stopes and other evidence of subsidence are described, together with the measures taken to restrict the damage, especially in its effect upon the recovery of ore. We conclude, not without regret, that the paragraph appearing in our issue of July 3, 1915, was true in substance and in fact, although official objection was made to that paragraph and we were assured—as we were not sorry to note in our issue of July 17, 1915—that "the loss of ore would not be serious and the workings were not endangered." Evidently they were, for in June 1915 a large cave developed between the 750-foot and the 900-foot levels of the Alaska Treadwell mine and big cracks appeared on the 440 and 600-foot levels of the Mexican mine, reaching the surface and endangering the Central shaft. Within a year thereafter the settling of the ground had damaged several buildings, including one of the stamp-mills. The crack near the Central hoist-building, first noticed in June 1915, has widened to four or five inches and is now supposed to extend to the 440-foot level at least. That the ground was settling, in consequence of the extensive excavations made in the lode, was known 11 or 12 years ago, as far back as the management of Mr. Joseph MacDonald. Cracks were noted near the big open-cut even at that time. As the huge pit or 'glory-hole' was enlarged, year after year, the support of the foot-wall was removed and the rock was pushed out, breaking in masses that slid to the bottom. One of such masses contained 600,000 cubic-feet, or 45,000 tons. As the open-cut was enlarged and deepened, partly by caving and subsidence, the broken ore was withdrawn at successive lower levels, and when the ground began to settle bodily the ore and rock were extracted through bulldozing-chambers, reducing the cost to a minimum and creating a fictitious notion of economy. It is doubtful if the ore produced below the 1700-foot level during recent years would have yielded any profit if it had not been for the self-broken ground above. When withdrawing ore in this way the management could not know from what part of the mine the product came, for in places the broken lode-matter ran freely and in others it was soon blocked. Evidently a long pipe of running ground was formed in one place, for roots and other surficial débris came down to the 1400-foot level. There has been a steady decline in grade below the 1700-foot level. As no more ore can be drawn from above this level until it is decided finally to abandon the workings, the available reserve has shrunk to a relatively small tonnage, considerably below that given in the consolidation report, for below 1700 feet there is not much ore assaying above the $2 per ton required to leave a margin of profit; it being probable that $2 will be the future cost, including loss in tailing. The point we make is that the figures of cost appearing in recent annual reports are illusory for the reason that insufficient allowance has been made for the large proportion of ore on which no mining or development work had to be done, thanks to the caving that in the end has proved so disastrous to the welfare of the mines.

This brings us to the danger of the mines being drowned by the admission of the water of Gastineau Channel, which is the strait that separates Douglas island from the mainland and under which the workings extend. Until 1916 the inflow of salt water was not serious, but during last year the volume of it is estimated at 39 gallons per minute. This is nothing in itself, but it may be ominous. The management believes that if proper precautions are taken "no disastrous flood of salt water will follow," and this, we may add, is the opinion of experienced men on the outside. The slimed tailing discharged from the four mills was expected to seal any cracks completely and thus serve as a protection from inundation. It is believed that this expectation is well founded, and attention is drawn to the fact that the lower levels are bone-dry. Several preventive measures have been suggested and every effort is being made to safeguard the mines. The report made by Mr. Bradley states the essential facts frankly and clearly. It is easy to be wise after the event, but for that kind of wisdom we have no liking, so that we do not feel called upon to offer any top-lofty criticism. All mines become subject to subsidence when an inclined lode is excavated over large areas to a great depth. That is the experience today in the copper mines of Michigan, on the Rand, and on the Kolar goldfield. The aim of engineering is to delay the subsidence and to save as much ore as possible up to the time when the mine has to be surrendered to the chief miner—nature.

DISCUSSION

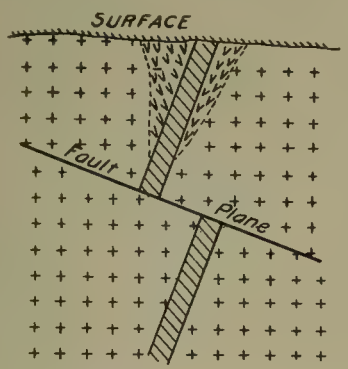
Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Effects of Faults on Richness of Ore

The Editor:

Sir—Relative to the enquiry appearing on page 902 of your issue of December 23, it is evident, although not explicitly stated, that the writer desires an explanation of the principles governing great variations in richness between specified portions of faulted orebodies.

In illustration of the point in issue, the accompanying



sketch shows a section of a vein that has been sheared, and then in part heaved from its original line to a new position, constituting a dip-fault. Of the two portions of this vein, that overlying the fault-plane has been enriched by ore-bearing material extracted from various sources within the inclosing rock, through decomposition due to weathering. Furthermore, and probably in preponderating measure, the upper portion has been enriched through progressive downward concentration within the orebody by re-precipitation from solution, much of the enriching material having been gathered from upper horizons that exist no longer.

In the process of downward enrichment, though the immediately higher portion of orebodies may be found favorably productive, it is quite frequently observed that special enrichment, from valuable material that has passed below the zone of weathering, occurs in the upper part of the zone of cementation, or zone of greater coherence. Such enrichment usually rests above an impermeable barrier—a fault-plane, for example.

That portion of the vein, underlying the fault-plane, may be considered as beyond the reach of important alteration, and so securely sealed overhead as to render appreciable subsequent enrichment improbable—the ore still retaining its main primary characteristics.

In orebodies displaced by strike-faults, analogous conditions, as far as the result of subsequent energy is concerned, are likely to obtain, owing to the probability of their separated parts lying in a common horizon.

JOHN F. MCLENNAN.

San Francisco, January 2.

Mining Law Revision

The Editor:

Sir—I have read with appreciation the editorial comment in your issue of January 13 upon this subject. It would appear that you are under the impression that objections to the mining laws are of recent date. Your remark to the effect that "thirty years ago their propaganda would have been timely" is but another illustration of the fact that those who criticise and oppose revision are not fully informed in the matter. More than thirty years ago a prominent mining engineer made the following statement:

"Enough has I think been adduced to prove that the present law is vicious and inexpedient, that its provisions bear hardly upon the mining industry, and it ought to be either repealed or essentially amended."

He continued his discussion of the conditions as they existed in his day by using the same terms: "Uncertainty of title," "fear of litigation," and "blackmail," which are today used in discussing this matter. (Document No. 233, 64th Congress, page 37.)

It further appears from your remarks that you consider "a detached view of this contentious subject" "the one qualification that those less minutely informed may possess." With this opinion thus frankly expressed I am quite in accord. Our critics and opponents seem to be equipped with this one qualification, and I leave it to your readers to decide whether intimate familiarity with a subject is not better qualification than "a detached view."

Answering now the inquiry contained in your last lines, I beg to call your attention to the fact that for the past four years those who have been recommending revision of the mining laws have expressed themselves as clearly in favor of the abolition of the 'discovery' requirement. Thus in the report of the Committee on Mining Law of the Mining and Metallurgical Society, dated March 15, 1913, the second recommendation reads as follows: "Mining claims should be locatable regardless of a 'discovery' and held only so long as the specified development work is performed," and in a communication to the American Institute of Mining Engineers in February 1914, a copy of which I enclose for your in-

formation, the question is considered at length, and the following statement appears: "The requirement of a discovery before location is antecedent to the granting of any exclusive possessory title, and is therefore not only irksome and deterrent of results in practice, but worn in principle." (H. V. Winchell, Trans. A. I. M. E., Vol. XLVIII, page 368.)

Now, Mr. Editor, I congratulate you upon the discovery of one feature of the mining law which needs revision. I feel encouraged and entertain hope that a few more steps of progression from the "detached view" will lead to the discovery of still other features in which improvement is possible and desirable.

HORACE V. WINCHELL.

Minneapolis, January 23.

The Mining Law

The Editor:

Sir—I would call attention to several suggested changes in the Federal Mining Code, which, being apparently subordinate, have been but little discussed, but which would, of enacted into law, have an effect greater, and more detrimental to the mining industry, than might be supposed. I refer to the proposals (a) that the new square claims shall have north-south and east-west sides, (b) that an equivalent sum of money may be paid into the U. S. Land-Office in lieu of the performance of assessment work, and (c) that a patent shall be applied for within seven years after location. I am not aware that there is any general demand for these particular regulations—in fact nearly all Idaho mining men are opposed to them, nor does it appear that any general good would result from them. We must not overlook the effect upon the prospector of any change in the present law. It is admitted that we ought to stimulate prospecting as much as we can, and if the discovery and development of mineral land is waning (except for the temporary stimulation given by War prices) under the present simple procedure for locating and holding a claim, we cannot expect any relief if we require more from the prospector than now is demanded. He is accustomed to staking his claim in a very simple manner, which is as it should be, for he prefers to spend his time in developing his find, rather than in setting his monuments at the corners of perfect rectangles. It would certainly work a hardship on him if he were compelled to have the boundaries of his claim on arbitrary courses, and particularly so if it were on unsurveyed land.

The prospector would receive no benefit from a regulation that would permit his neighbor to pay the Land-Office $100, or any other reasonable amount, in lieu of doing his annual work. Admitting that many prospectors try to hold more claims than they can 'represent' properly, I think the majority try faithfully to perform their annual work, and they would regard such a regulation as class legislation favorable only to the non-resident owner who is not diligent in improving his property.

In the West many claims are owned by men who are financially able to perform only the necessary annual labor. The development of these claims progresses at the rate of $100 per year, and very few of them can make such a showing in seven years that capital may be secured to complete their development, and only an occasional one makes a mine in that time. As it costs about $300 to patent a 20-acre claim, such a law would mean at best that the development of each seven-year-old claim owned by poor men would be arrested for three years, and in many cases would compel a complete abandonment. Is that not depriving a man—an indispensable man in the mining business—of his property without compensation? Multiply the development done in three years by the number of seven-year-old claims in the entire mining territory of the West and the product will be the annual cost to mining development.

Any change in the law that applies particularly to prospectors, except perhaps a regulation that will cause, in those cases where there is delinquency, a full compliance as to annual labor, will work a hardship on prospectors, and will defeat one important object sought to be attained by a new code, namely, the stimulation of prospecting and development.

A. E. ROBINSON.

Boise, Idaho, January 19.

Ball-Mills

The Editor:

Sir—Wet-crushing ball-mills are occupying the keen attention of every progressive and up-to-date metallurgist at the present time. Interesting articles and discussions have appeared in your paper on this subject during the past year.

I recall the discussions appearing in the *Mining Magazine* during May to August 1914 between Messrs. Hardinge, Farrant, Catlin, and myself regarding short tube-mills *v.* conical mills. At that time short tubes (wet crushing cylindrical ball-mills) were not in use to any extent in the United States. Their development here has taken place during the past two years. They are rapidly taking the place of stamps, rolls, and Chilean mills.

The efficiency of the ball-mill will be increased materially in the future by a more complete elimination of the undersize material from the feed. At the present time this undersize product, included in the direct and return feeds, amounts to as high as 20 to 30% in some mills. Screen-classification would more completely accomplish this than either hydraulic or mechanical-screw or rake classification. There is plenty of room for improvement along this line.

I believe that a Krupp ball-mill that is largely used throughout Western Australia is worthy of some consideration. There it is used mainly for the dry crushing of telluride gold ores, which require complete roasting before cyaniding. This ball-mill when used for wet crushing should have a large capacity owing mainly to the large peripheral-screen discharge. As soon as the ore becomes fine enough, it is immediately discharged from

the mill, and there is practically no unnecessary grinding. Any machine that discharges its product quickly, when it becomes of the required size, will be the most efficient.

Has the Krupp mill ever been used for wet crushing in this country? If not, what are the arguments against it? Let us have some discussion on the Krupp type of mill *v.* the Marcy.

A. E. Drucker.

New York City, January 3.

[The chief argument against the Krupp mill is that Essen is blockaded.—Editor.]

Some Pertinent Questions

The Editor:

Sir—The questions asked by A. B. C. in your issue of January 13 are good subjects for discussion, but they are stated too indefinitely to receive definite answers. There are too many conditions affecting work underground, such as hardness of ground, size of opening, condition of equipment, and so forth, to permit of explicit answers to most of the questions. Nevertheless, to help the discussion along, I beg to submit the following answers, strictly off-hand:

Question: How many feet of drilling should be done by a miner on an 8-hour shift, working with a single-hand hammer?

Answer: Anywhere from six inches to 50 ft. There is ground in the Cliffs Shaft mine where a man couldn't drill six inches a shift with a single-hand hammer, and I have seen a man put in three five-foot holes in the ore in the Ashland mine with a jumper in ten minutes. These represent the extremes.

Question: Same as above, but with a drill of the jack-hammer type?

Answer: Drilling-speeds by test, run from less than one inch per minute to more than two feet per minute. And the amount of drilling a man should do in a shift varies in somewhat the same ratio. A man can't stand the vibration from one of these machines during the whole shift, and should have a chance to change off part of the time at some other occupation.

Question: Same as above, but with 3¼-inch piston-drill, using 90 lb. air-pressure?

Answer: Few men are interested in 3¼-inch piston-drills nowadays, except in quarries. When the ground is too hard for a jack-hammer, it is time to rig up a No. 18 Ingersoll-Leyner, or a Sullivan DR6, or a Denver Dreadnaught.

Question: How long a time should a shoveler take to fill a car of 1800 lb. capacity with ordinary quartz ore, or rock, shoveling from the rock-floor of a drift?

Answer: About 20 minutes. The character of the ore, size of pile, size of drift, and height of car are all functions of the variable, to say nothing of the method of payment. Some men do well to load 10 tons per shift, and others will load and tram 18 tons every day. I would be almost ashamed to say how many cars I have seen three men load in a shift in the Roosevelt tunnel.

Question: What is the average cost of shoveling a ton of rock into a car from a rough floor underground when no shoveling-plank or metal sheet is used?

Answer: About 15 cents. Here again the conditions of work as well as the wage-rate and system of payment are controlling factors.

Question: What is the increase of efficiency if a shoveling-floor of plank or a metal sheet is used?

Answer: About 20%. In soft hematite there is little, if any, increase in efficiency, most of the 'mucking' being from the top of the pile. In extremely rough ground the increase may be as high as 50%.

Question: How far is it safe to carry the face of a drift beyond the last set of timbers?

Answer: Somewhere between six inches and 6000 ft. There are places in the Salisbury mine where it is unsafe to open up at all beyond the last set of timbers without fore-poling. A little over a mile away at the Cliffs Shaft mine there is a drift on the 10th level that is nearly 6000 ft. long without a stick of timber in it.

Question: How far should a trammer push a loaded car on a fair track underground in one minute?

Answer: About 250 ft. The size of the car, grade, and gauge of track, size of rail, length of wheel-base, and type of bearings all have considerable influence on speed of tramming. As a general thing a short wheel-base, narrow gauge, light track, and roller-bearings give the best results. These results are usually obtained where the car is light and the grade is such that the men can ride out with the load. This can be easily accomplished by using roller-bearings.

Question: What is the best angle of inclination for a raise that is to be used for the passage of ore or rock?

Answer: About 65°. With hard ore running down long raises that are not timbered it is well to have a bend in the raise about 25 ft. above the chute, the bottom 25 ft. being at an angle of 50°. This takes the weight off the stoppers or fingers.

Question: How many cubic feet of quartz in place are required to weigh one ton?

Answer: 13.

Question: How many feet, if broken?

Answer: About 20 in a skip or car—16 or 17 in a good-sized dump.

Question: How many cubic feet of fresh air per minute should be sent to the face of a drift where two men are at work, where the place is lighted by candles—one for each man?

Answer: 200 cu. ft. The amount of air per minute per man underground required by various statutes varies from 50 to 300. With much decaying timber 200 cu. ft. per man per minute has proved satisfactory. Without rotten timber 100 cu. ft. per man per minute should be ample, especially if carbide lamps are used instead of candles.

Question: What number of hours of actual work per shift results in the greatest efficiency of men?

Answer: Seven.

Question: How far apart should loading-chutes be placed on a level to get the greatest economy in handling ore in the stope above?

Answer: 25 to 30 ft. Here again the width of the vein and the amount of the ore to be passed through the chute have an important bearing on the decision. If chutes are not more than 30 ft. apart on centres no tramming is necessary in the stopes.

Question: Is the bonus system advisable in underground work? If so, why?

Answer: Yes. By paying a man a minimum wage with a bonus for every ton of ore or foot of raise or drift, or for every ton of ore or foot of raise or drift over a certain amount, a more uniform rate of payment per unit can be set than with a straight contract system, where supplies are charged to the contract. The labor charges for different kinds of ground are much more uniform than the supply charges. The bonus system also prevents disputes as to the rate to be charged for supplies furnished.

Question: Is the contract system in mining-work a good one? If so, why?

Answer: Yes; but in many ways the bonus system is better. With uniform conditions of work the contract system works out very well. In tramming, a system based on the cost of filling the car and the distance trammed is advisable. I worked out a system of this kind at the Cliffs Shaft mine a few years ago, and at the same time a similar system was started by the Moctezuma Copper Co. with good results. Wages are radically different at the two mines, but the cost per ton was nearly equal.

LUCIEN EATON.

Ishpeming, Mich., January 17.

The Great Calamity

The Editor:

Sir—May the very small voice of femininity speak in the great engineering world? First, I want you to know that you have among your faithful followers an embryo mining and metallurgical engineer of the feminine persuasion; some day I may want to "speak out loud" and I don't want to take you by surprise.

Inspired by your worthy editorial on 'The Great Calamity' and its reformatory result, as confessed to by the gentleman who refrained from "making an ass of himself," comes this idea: who of us would have the courage to dispense with tobacco at one of our banquets and use the money saved for charitable purposes? Or why not put aside for the Belgian Kiddies the price of a box of cigarettes every time "we" indulge in such a luxury?

M. L'A. C.

Stanford University, January 22.

[Certainly, the lady ought to put aside her cigarettes "for the duration of the War" and give the saving to the Belgian Relief Commission. We know several men that have abstained from the use of cigars—substituting the pipe in order to save money for this worthy purpose. We are glad to count this fair correspondent among our subscribers and are aware that we number among our readers many of the wives of mining engineers and metallurgists. It is an honor and also a stimulus to good work, for there is no better critic than a refined woman. —EDITOR.]

Taxation of Mines

The Editor:

Sir—Referring to the editorial in your issue of the 20th instant, on 'Taxing Mines in London,' your readers may be interested to know that similar taxation is proposed in Australia. A bill known as the War Time Profits Tax Assessment Bill was tabled in the House of Representatives by the Commonwealth Treasurer in May last, but was shortly afterward withdrawn for further consideration in consequence of representations that were immediately made to the Minister by representative mining men and others as to the unfair incidence of and far-reaching effects to be anticipated from the proposed taxation in certain cases and in certain ways such as those to which you refer. The bill, which has since been re-drafted, is to be debated by Parliament in March next and is expected to become law during that month. Meantime, as a result of the further consideration given to its provisions and as a result also of the representations made, the Government has announced that gold mining is to be excluded from the incidence of the taxation and that it is proposed also to introduce other modifications to meet, to some extent at least, the special case of the mining industry, particularly new mines.

It may also interest your readers to learn that one of the Australian companies mining for tin in the Malay Peninsula has recently transferred its place of incorporation from Australia to the Federated Malay States, and further that another Australian group that proposes to equip a tin mine in Bolivia is arranging to incorporate the undertaking in the United States.

W. A. FREEMAN.

San Francisco, January 22.

ALUMINUM WIRE as a substitute for copper in electrical transmission of power has been adjudged as unsatisfactory. Aluminum is a good conductor of electricity but to secure equal efficiency the sectional area of the aluminum wire must be much larger than that of copper to carry a given current. Moreover, the aluminum wire has been found to crystallize from the swaying of the wires in the wind, which causes them to break. Several aluminum-wire lines, constructed at great expense, have been replaced by copper, the aluminum being re-melted into bars for manufacturing into other articles.

BURMA is the largest producer of tungsten ore in the British Empire. The production in 1915 was 2645 tons of wolframite. It is expected the output soon will reach 4000 or even 5000 tons annually.

Gold and Silver Mining in Chihli, North China

By A. S. Wheler and S. Y. Li

CUPELLATION FURNACES

CONCENTRATING SILVER-LEAD ORE

CRUSHING MILL

DRESSING-FLOORS

Chihli is the northermost of the 18 provinces of China proper and lies partly within and partly without the Great Wall, which zigzags across it in a north-westerly direction from Shan-hai-kwan, a small watering place on the Peking-Mukden line of railway near the port of Ching-wang-tao on the gulf of Chihli, west of the town of Kalgan. This place marks the entrance to the pass leading up to the Mongolian plateau and lies on the trade-route followed by the picturesque camel caravans which come from the north to Peking during the winter season. An inner rampart branching from the Great Wall about 40 miles north of Peking traverses the province in a south-westerly direction until it reaches the boundary of Shanshi province, where it again forks, one arm going westward and rejoining the Great Wall in North Shansi, thus forming a loop, and the other runs southward marking the boundary between the two provinces.

The area of the province is approximately 116,000 square miles, or slightly less than that of the British Isles, and the population has been estimated at 21 millions. Northern Chihli, or that portion of the province lying north of the outer Great Wall, covers rather more than half this area, but it is sparsely inhabited in comparison with the southern half.

The climatic conditions present the extremes of an excessively hot summer, with torrential rainfall in July and August, and a bitterly cold winter with ice-locked ports. The normal range of temperature is from 105° to 0° F., the pleasantest months being May, October, and November. The late winter and early spring months (February to

April) are marked by persistent winds and appalling dust-storms from the Gobi desert.

With the exception of the special administrative area of Cha-ho-er, embracing Kalgan and district, North Chihli is administered by a Military Governor quartered at Jehol or Cheng-teh-fu. This was the ancient capital of Mongolia and the place where the Emperor Chien Lung, in the middle of the 18th century, built a beautiful imperial palace which was used as a summer residence by the court until 50 years ago, and also where the Macartney mission was received in 1793. In the neighborhood are some fine Buddhist monasteries and pagodas, notably the Buddha-la, said to be a replica, on a small scale, of the Llamaserai, in Thibet. But "the glory has departed," both palace and monasteries are rapidly decaying, and were it not for the garrison the place would sink into insignificance.

The chief commercial centre of North Chihli is Chihfêng (Chinese name) or Wu-lan-ha-ta (Mongol name, usually abbreviated to Ha-ta). It lies 140 miles northeast of Jehol by road and can boast one of the largest grain and beef markets in North China, and the second largest horse-market. It does a thriving trade in flax and hides, and there are numerous distilleries for the manufacture of millet spirit in the neighborhood.

The railways of China may be said to radiate from Peking. These are the Peking-Mukden, connecting with the trans-Siberian route to Europe; the Peking-Hankow, on which is situated Pao-ting-fu, the old provincial capital; the Peking-Ta-tung fu, passing through Kalgan, and the Tientsin-Pukow joining by ferry across the Yangtze river with the Nanking-Shanghai railway. North Chihli possesses no railways; all transport is by cart or pack-animals over atrocious roads or by the few rivers that, during the summer months when water is high, will permit the passage of light shallow-draught native craft. These are 40 ft. long by 8-ft. beam, draw up to 12 in. of water, and can carry two or three tons of cargo. They travel rapidly down-stream on the swirling current and have to be towed laboriously up-stream by a gang of coolies or trackers.

While the cost of both road and river transport varies greatly, depending largely on the season and the bargaining ability of the hirer, some figures may be quoted to give a general idea of the expense. On the Lan-ho river from Jehol to Lanchow (on the Peking-Mukden railway) a distance of 170 miles, native boats carrying 4000 *catties*[1] can be hired at ₱15 for the trip,[2] which takes from 3 to 5 days, depending on the state of the water. This corresponds to 10s.4d. per ton of 2000 lb., or 0.75 cent per ton-mile. Traveling up-stream, the rate and the time taken to complete the trip are about double.

From Chin-chou, on the Peking-Mukden line, to the Chuan-shan-tze gold mine, a distance of 180 miles by road, the cost of transport is ₱120 per wagon-load of 4000 to 5000 lb., or £4 17s. per ton of 2000 lb., or 13 cents per ton-mile, while the ordinary small Peking cart, capable of taking 500 to 600 lb., and drawn by two animals harnessed tandem, can be hired at ₱22 for the trip. After traveling over the roads in North Chihli, if indeed a boulder-strewn river-bed can be designated as such, one thoroughly understands the reasons that prompted the design and structure of the Peking springless cart.

While on the subject of travel, a word of warning must be given, for the benefit of the uninitiated, about Chinese inns. Don't stay at one if you can possibly avoid it! The interior of China, in this respect at least, differs but little from the England of Chaucer's day. If unavoidable, and this is often the case, especially in South China, be armed with a plentiful supply of strong disinfectant and apply it liberally. A temple, school-room, or part of a private house is often procurable by sending a forerunner, and affords welcome relief. In North China a suitable spot for a camp can usually be found when the halt is called, but this is not often the case in South China, where the land is so closely cultivated. Wherever he may be, the foreigner traveling in the interior must make up his mind to dispense entirely with privacy; for, apart from the fact that the inn is to all intents and purposes a common-room for all sorts and conditions of men (and vermin!) he will find that, whether sleeping or waking, eating or drinking, bathing or dressing, he affords a never-failing object of interest to a swarm of villagers, who apparently regard him in much the same way as does a bank-holiday crowd the animals in the Zoo. But one must in justice acknowledge that, apart from their inordinate curiosity, the crowd is usually extremely well-behaved, and if the foreigner can turn the joke against one of them he will instantly win their goodwill and favor, for the Chinese have a large fund of good humor.

Geological Features. The complexity of the geological structure of the mountain region of North Chihli is such that many years of arduous work would be necessary before anything in the nature of a reliable geological map could be presented. In general terms, however, it may be stated that the main features consist of a basal complex of schist, gneiss, and highly metamorphosed rocks of probably both igneous and sedimentary origin, which may be classed as Archean.

Overlying these unconformably, and often showing a high degree of metamorphism and folding, is a great thickness of limestone, quartzite, and schist, the first named predominating and forming the ore-carrier of the principal mineral deposits. Both these systems have been intruded by acid igneous rocks. Following this, and belonging to a much later period, is another series consisting principally of limestone, with sandstone, shale, conglomerate, and igneous sills. This formation is found principally as outliers, and contains coal seams that are worked at numerous places.

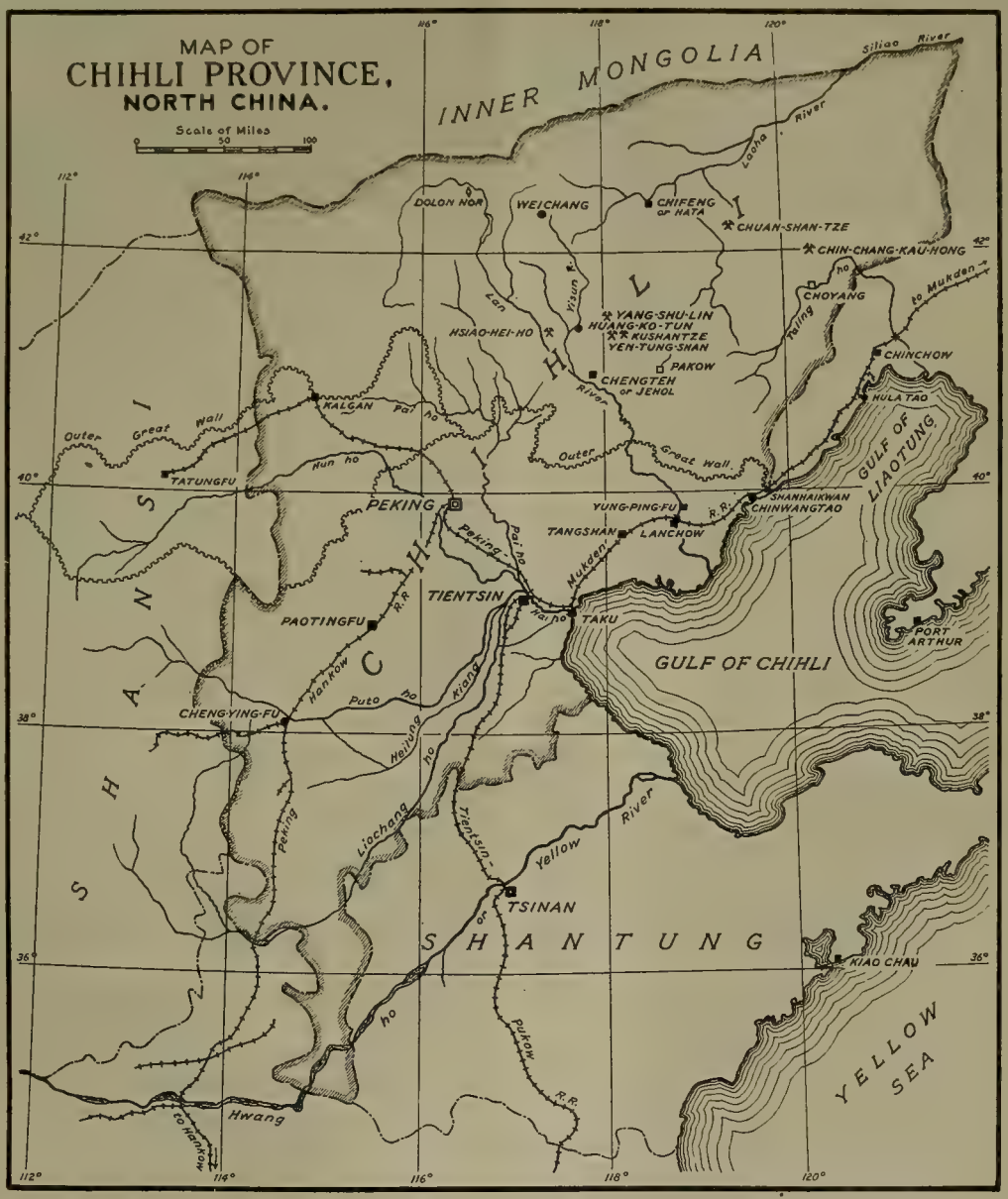
On top lies the 'loess,' that remarkable sub-aerial deposit of northern and western China, so often obscuring the rocks of both hill and valley. It weathers into fan-

[1] A table of Chinese weights and their Anglo-American equivalents is given at the end of this article.

[2] We use the 'peso' sign to indicate the Mexican dollar.—Editor.

tastic ridges or deep ravines with vertical walls that stand well, and the poorest class of Chinese takes advantage of this to excavate cave-dwellings. As agricultural land it is moderately productive, but it is continually being washed away, choking the rivers and slowly modifying the coast-line of the Gulf of Chihli.

Gold Mining. The wide-spread occurrence of gold is amply indicated by the numerous old workings scattered throughout the more mountainous districts. Work is still done in a spasmodic and desultory manner at many points, and the alluvial deposits in the river-beds and valleys are also worked by the farmers in the off season, when no other work is obtainable, 40 cents (Mex.) per day being considered abnormal earnings. The alluvial workings consist of small holes in the river banks, from which the boulders and gravel are raked out and the dirt carried to the water and panned. Although probably most of the gold was, and still is, won from the alluvium, in no instance under our observation had bedrock been touched. This is doubtless due in most instances to the depth to bedrock and to the fact that alluvial mining is carried on by individuals of the poorest class who are totally unable to cope with the water; even were they financially able to do so, it must be remembered that the Chinese rarely expend any appreciable amount of capital on mining work for which they cannot see a good prospect of immediate return.



[3] 'Metal Mining in the Provinces of Chihli and Shangtung,' Trans. Inst. Min. & Met., 1900.

bedrock at the Chin Changkuo Liang mine, but this would appear to have been of ancient Korean origin. This property, which is 25 miles north of Chao-yang, was worked for both vein and alluvial gold, the latter being by far the more profitable, but work was abandoned many years ago, though a little washing is still occasionally done.

Many of the small mines, both those abandoned and now in operation, are quartz veins of the pegmatitic type, segregations of quartz in veinlike form in granitic or gneissoid rock, or contraction-fissures. Where these attain a reasonable stoping-width they are usually barren, and where narrow, or consisting of a series of thin stringers, are extremely patchy; they almost invariably pinch out or merge into the country-rock at comparatively shallow depth—a common experience with this class of veins.

Where the country-rock is limestone the vein is generally more persistent, and the gold is usually associated with galena and pyrite.

The principal gold mine now working in North Chihli is the Chuan-shan-tze, 50 miles south-east of Ha-ta. The formation is limestone intersected by dikes of granite. In the hills surrounding the mine there are at least ten lines of ancient workings, some of which extend for a distance of over 1000 ft. on the strike, but as they have not been worked for the last 30 or 40 years, and are now inaccessible, nothing is known as to the gold contents of the ore. The present operations are confined to an orebody having a north-west strike and dipping 65° northeast. This is apparently a fissure-vein, though the walls are in places so poorly defined that it has rather the characteristics of a mineralized channel or impregnation, indicating subsequent metasomatic action.

The workings extend over a length of 900 ft. and to a maximum depth of 600 ft. The three main openings can hardly be dignified by the name of shaft, since they follow a zig-zag course downward, with drifts or stopes as is convenient. The width of the stopes averages three feet. They are invariably carried underhand and the working-faces, of which there are rarely more than two or three, are generally the deepest places in the mine. This is in accordance with Chinese practice, which consists in working out all the pay-ore as fast as found without ever a thought of creating a reserve.

The vein exposed in the three working-faces is a well-mineralized body of ore about three feet wide intersected with veins of calcite and carrying galena, iron, and copper pyrite, and occasionally mispickel. The ore is rough-sorted underground and carried up in baskets to the nearest windlass, often a distance of 200 ft., whence it is hoisted in three stages to surface.

The small amount of water is raised by hand-pumps in four lifts. Windlass and pump-men are paid ₱4 per month and work 6-hour shifts, on and off.

All dead-work, driving and winze sinking (4 by 6 ft.) is paid for by the company at ₱9 per foot.

The explosive used is black powder of local manufacture and costs 60 *coppers* per *catty*, say 15c. per pound; the miners work single-hand, usually putting in a 15-in. hole, which is charged with four ounces of powder.

The method of ore-treatment is as follows: The fine is concentrated in a small washing-plant near the shaft-mouth before being sent, together with the coarse, to the mills. The waste, discarded by the miners underground, and the tailing from the fine, is carefully re-sorted by boys before final rejection. This ore is broken by hand to about walnut size and is then dried on galvanized-iron sheets over a fire; this is not done with the object of roasting, but to render it brittle for crushing.

The crushing-mill consists of a cylindrical granite-roller rotating about a vertical wooden shaft fixed in the centre of a slightly basin-shaped granite base. The roller-axles are set centrally in a rectangular wooden frame, which is fixed slightly eccentric to the vertical shaft; the result being that a considerable grinding effect is produced when rotating. This action is strongest at the apex of the granite base, which is of harder rock than the roller, so that the latter takes most of the wear. When worn at one end it is reversed. A roller lasts from one to three months. The mullers are dragged round by ponies harnessed to poles, which are extensions of the side pieces of the frame. The ore is crushed dry and is fed by hand around the vertical spindle. The dimensions of the larger mills used for coarse crushing are roughly: base, 6 ft. diam. by 10 in. thick at outer edge and 13 in. at centre; roller, 30 in. long by 21 in. diam., set about 6 in. out of centre with the vertical spindle. The capacity may be taken at about 600 *catties* (about 800 lb.) per 24 hours, reducing to 10-mesh.

The dry-crushed ore is removed from the mill, mixed with water, and taken to the dressing-floors. These consist of a series of pairs of tables, or sluicing-down boards, about 6 ft. long by 2 ft. wide with 5-in. free-board and set at 10 to 15% slope. A layer of pulp about two inches thick is placed at the head of the table and water allowed to percolate over it. The dresser then starts working it over, raking down a little at a time, until he has completed the whole layer, the bulk of which is retained by a V-trough at the lower end of the board. He then rakes this up again and forks it over afresh, the tailing from this first washing being run to waste.

It is then shoveled onto the platform between a pair of tables and receives a similar treatment on a second table. The overflow from here is collected and re-ground in a small roller-mill and again passed over the tables.

The above process is repeated on an average four or five times and occasionally as often as ten, until a sufficiently high-grade concentrate has been obtained, with a reduction in bulk to about 1% of the original picked ore. It is finally panned down by hand to obtain the free gold, which is smelted into bullion running about 800 fine.

The tailing from the floors is repeatedly re-treated by outside workers, or 'streamers,' who are said to be able to earn up to 40 cents (Mex.) per day, it being stipulated that the concentrate shall be sold only to the company.

The mine is operated on a tribute system; the con-

tractor both mines and dresses his ore, providing all the necessary labor, tools, explosives, and lights. The company hoists the ore to surface, does all the pumping, provides all the timber, which has to be placed by the contractor, supplies the mills and animal power, and dressing-plant, and buys the gold from the contractor at ₱15 to ₱20 per *liang*, or roughly at about one-half its value!

The output in 1913 and 1914 was about 130 oz. per month, or just about sufficient to meet expenses; in 1915 it rose to about 250 ounces.

It is certain that a considerable amount of illicit gold-buying takes place, which is not surprising under the circumstances, despite the fact that precautions are taken to guard against it.

There are no reliable statistical data as to the output of gold from North Chihli, but it is safe to say that it is well under 10,000 oz. per annum and probably does not exceed 7000 ounces.

Silver Mining. The silver produced in North Chihli is all obtained from deposits of argentiferous galena, which are found either in the form of quartz veins in granite, or as replacement-deposits or fissure-veins in limestone.

The former type of lode is being worked at the Yü-cheng company's four mines in the Hsiao-hei-kou, Lung-hua magistracy, 30 miles north of Jehol, and 12 miles west of the town of Huang-ku-tun, which is on the Yi-shun river, a tributary of the Lan-ho. At high-water shallow-draft boats can reach this point, but Jehol is the normal head of navigation.

The veins often show a pegmatitic structure. They are narrow and extremely erratic, and the galena occurs in them in small stringers and bunches. The output from these mines is meagre, and their capacity for production is limited.

The deposits in the limestone are larger, and from these the bulk of the silver output has been, and still is, derived. The principal mines are the Yen-tung-shan, Ku-shan-tze, and Yang-shu-lin, in the Jehol mining district, 30 miles north-east of the town of that name.

The first-named is a fissure-vein with an east-west strike and a dip of north 75°; it is traceable for over five miles and workings are found at numerous points along it.

The enclosing rock is limestone, in places highly metamorphosed, and the deposit occurs near a fault-contact with schistose rocks, both formations being greatly disturbed by acid-igneous intrusions. No igneous rock was actually observed, however, underground.

The mine is now being worked by a low adit driven east for 1250 ft., giving 800 ft. of back, which, however, is honeycombed with old workings and for the most part exhausted. A second adit, known as the Lo-to-po mine, driven on the same lode but some distance east of the above, is also being worked, the ore at both places being mined below the adit-level.

The galena occurs in association with blende, usually as a stringer or vein a few inches wide, opening here and there into small bunches and pockets of ore, though occasionally a lens containing several hundred tons of high-grade ore is found, affording periods of prosperity in an otherwise feeble exploitation.

The Ku-shan-tze mine is about six miles east of Yen-tung-shan and was worked for a few years, about 1888, under foreign (American) technical control, but proved a failure, owing, it is stated, to the loss in concentrating and to the high price of fuel. Chinese methods were then reverted to, steam-pumps being used to handle the water, which is reported to have been considerable, the depth of the workings being 850 ft. Finally the lower levels were abandoned and the water rose to the 170-ft. level, where it now stands.

The old stopes above this show that the orebody is a typical replacement deposit in limestone and consists of a series of roughly parallel irregularly shaped masses, which are reported to unite in depth and continue as one body below the 260-ft. level. The present output is being obtained by following the numerous small veins and leaders of calcite, usually less than six inches wide, and carrying finely disseminated galena with stringers and occasional bunches of ore. These form connecting links or channels between the larger deposits. They can only be regarded as the remnants of the once extensive orebody, though it is stated that the deposit has by no means either pinched out or been worked out below water-level.

The Yang-shu-lin (or Pang-chia-ko) mine lies about 15 miles north-west of the former. It is, like the Ku-chan-tze, a deposit of metasomatic origin, the ore being galena

associated with blende in a calcite gangue. It is irregular in shape, the orebodies, great and small, ramifying in all directions, and connected by small leaders of ferruginous calcite, often barren, but now constituting the only available source of ore. The old workings cover a distance of about 350 ft. and extend to a depth of 250 feet.

All these mines are worked on a tribute system arranged as follows: The headman of a 'chore,' consisting of seven men, selects a 'pitch.' This is a working-face about 60 ft. long; and in the selection of these it is a case of 'first come, first served.' He then makes a contract with the office-men or mine-officials, being required to find an approved guarantor, if not possessing sufficient means himself. The contract binds him to confine his mining to the working-face assigned to him and to carry on work there continuously under pain of forfeiture should he fail to do so for a longer period than half a month.

Of the silver produced, the company first takes its tribute, which amounts to 10% on a total output not exceeding 500 *liang* (or 600 oz.), 15% on a total output not exceeding 1000 *liang* (or 1200 oz.), and so on, 5% being added for each additional 500 *liang* up to a maximum of 30% tribute on 2500 *liang* or more, always reckoned on the aggregate of silver produced by the tributer while working the mine.

The guarantor then takes his 10%, after which deduction is made for smelting charges (fixed), tools, or any supplies, including advances and food, and the balance is divided among the party, the head-man receiving twice as much as the others.

If the ore is poor the company may agree to accept less tribute, but in practice the tributer is charged with sundry extras that bring the amount up to the company's regular figure.

The following is a copy of a tributer's account.

CHENG PING WESTERN OFFICE

Kung Fa party.

		Taels (1 *tael* = ₱1.44)
One ingot of silver bullion weighing 73.26 *liang* (87.91 oz.) at 960 fine	70.32	
Less company's tribute of 20%		56.25
Deduct: Smelting charges, 10%	5.63	
Tools	1.62	
Advance	0.14	
Water money (repairs, power and water)	1.47	
		8.86
Balance due		47.39

The company usually pays for dead-work in limestone at the rate of 1.5 *taels* (₱2.2) per foot, whether driving or sinking. The tributer builds his own smelting-furnaces with material supplied, and does his own smelting, using charcoal for fuel, costing 5 *taels* per 1000 *catties* (25c. per 100 lb.). The company employs numerous watchers to guard against theft of ore or bullion.

Historical records show that the smelting and refining of silver has been conducted extensively in China for centuries, and it is probable that the methods at present practised have undergone but little alteration for several generations. The appliances used are shown in the accompanying illustrations and a description of the process is as follows:

The ore is rough-sorted underground and then cobbed and close-sorted at surface. The waste and fine are concentrated by washing in scoop-shaped wooden dishes.

The roasting is conducted in kilns, of 5 to 6 ft. diam. by 3 ft. high, with a discharge opening, and built of sun-dried brick, having staggered vent-holes in alternate tiers. The ore is packed in layers two or three inches thick with charcoal between each bed, on a bottom layer of firewood, which is then lit, and the charge allowed to burn out. In the case of high-grade concentrate two such roastings, requiring three days to complete, may be given, or where the galena content does not exceed 50% the process may be omitted entirely. The roasting is far from being uniform and part of the ore is generally found to have been fused, or reduced to metal, while other pieces are merely burnt superficially. When the kiln is discharged these latter are picked out and added to the next charge. The charcoal consumption varies from 2½–1 of charcoal to 1 of ore.

The smelting is done in beehive furnaces built of brick smeared with mud. The dimensions are about 3 ft. high, 2 ft. diam. at the hearth, and 1 ft. at the throat; a tuyere for the blast (supplied by a double-acting Chinese bellows) and also a tap-hole, are built in; the hearth is of compressed wood-ash and a swell, or 'belly,' in the furnace keeps the tuyere free, helps to distribute the blast, and holds up the ore in the reducing-zone. The flux used is old cupel-bottoms or wood-ash impregnated with litharge; the fuel is charcoal, the consumption of which varies from 6 (or less) to 1 of ore. It is added with the ore, about 10 lb. at a time, until the capacity of the furnace has been reached, which is usually about 130 lb. The blast is continued for two hours, when the dense sulphurous fumes given off at the start have ceased. The slag is then tapped and the furnace cooled after a brief interval by a douche of water, to be broken down and carefully sorted over.

The cake of lead is hammered free from slag, and cupelled on an oval hearth built of wood-ash compressed by foot and scooped out to the required shape. On this the lead-cake is placed, and a muffle of brick plastered with mud is built up on it. Charcoal is heaped over this and fired, and the whole is covered by a dome of brick plastered with mud; a circular opening is left at the top for feeding fuel, and the mouth of the muffle is closed against draughts by a brick. The charcoal consumption is 4 to 1 of lead-cake and the cupellation takes about 10 hours to complete. When the finishing-point is reached, after 'flashing,' a green stick is passed lightly over the surface several times and a gentle air-blast is blown into the muffle. This removes the impurities. The silver quivers and glows, showing solidification. It is then cooled off, and the furnace is broken down and carefully sorted over.

The silver thus produced will run 980 fine, and after weighing, is re-melted and either cast into *sycee* or 'shoes' of about 60 to 70 oz., or into buttons of 6 to 7 oz., these being alloyed with 2% of copper.

The fineness of silver (and also of gold) is estimated by its appearance and cut, and the degree of accuracy attained by those whose business it is to value *sycee*—this is monopolized by a few families that have done it for generations—is remarkable; they can judge it to within one or two millièmes.

The annual output of silver from the mines in Chihli has declined heavily during the past 20 years. Hoover gives it at 140,000 oz. in 1898, whereas it does not now exceed 30,000 oz., if indeed, it reaches that figure.

Conversion of Chinese weights into British equivalents, as determined by Presidential decree of March 1914:

1 liang (or tael)	=	24 dwt. (Troy)
1 " "	=	1.31 oz. (Avoir.)
1 catty (or chin)	=	16 liang
1 " "	=	1.31 lb.
1 picul (or tan)	=	100 catties
1 " "	=	131.6 lb.
1 " "	=	0.0587 long tons
1 " "	=	0.0658 short tons

Exchange fluctuates widely; it has here been taken at ₱11 to the £1; at which ₱1 = 21.82d. The Mexican dollar exchanges locally for 120 cents silver or 135 coppers. The tael—dollar exchange may be taken at T1.69 = ₱100.

Molybdenum

The early expiration of the Halcomb patent, held by the Crucible Steel Company, which practically controls the use of molybdenum in the United States, renews interest in those concerns producing this modern steel alloy, as it places them in a position to obtain a better market for their product.

Molybdenum alloy used by the Krupps, increases the life of rifled guns, giving the steel a hardness that no other alloy, not even tungsten, produces. The use of it in the United States has been restricted by the blanket patent which the Crucible company has held.

The chief production of molybdenum in America comes from Canada, the most valuable properties being in Ontario. Here recent discoveries of the ore, such as the mine of the Steel Alloys Corporation at Renfrew, make it possible for the United States to obtain supplies both for ordnance and industrial use.

Coal recovery in the anthracite mines of Pennsylvania is stated to be about 65%. This means what at present appears to be an unavoidable loss of 35% of the coal due to mining methods and handling. The cost of production is an important factor in the causes for this heavy loss. If the coal operator could demand a higher price for his coal without increasing the cost of mining it, undoubtedly the loss would be correspondingly reduced.

Cost of Mining in Yukon Basin

The cost of mining is always interesting, particularly in regions at a distance, and where unusual conditions prevail. The Canadian Department of the Interior has recently issued a publication describing the Yukon Territory, in which is given the cost of mining in the Yukon Basin, and from which the following is abstracted: The cost of a complete pumping, thawing, and self-dumping equipment for working ten shovels, designed especially for the Yukon, to serve as a light and simple machine to hoist and convey dirt from a shaft or open-cut to the dump, or sluice-box, is $3205. The cost of sinking a shaft 8 by 8 ft. to a depth of 30 ft. by the self-dumper is stated to be $9.16 per foot. When a shaft of the same size was carried to a depth of 55 ft., hoisting with windlass, the cost was $9.96 per foot. Tunneling by self-dumper, 6 by 6 ft., cost $6.44 per foot. The cost of thawing, hoisting, and sluicing over 590 sq. ft. of bed-rock where the gold-bearing gravel removed was three feet deep was $179.75 or 30c. per sq. ft. of bed-rock. The working-cost of a self-dumping plant having a capacity for handling the gravel on 600 sq. ft. of bed-rock, three to four feet deep, was $189.38 or 31c. per sq. ft. of bed-rock. Two men thaw and take out six feet of dirt in a shift of 10 hours. One cord of wood will make steam sufficient to thaw a shaft 30 ft. deep. From the bottom of a shaft two men will thaw and drive 3½ ft. in a drift 6 by 4 ft., and hoist the gravel with a windlass in one shift of 10 hours. The cost per foot is $2.50. On Bonanza, Hunker, and Eldorado creeks, in one season, 5,133,575 cu. yd. of gravel was dredged, producing $3,343,667, at a cost of 29.53c. per cubic yard. This included depreciation. Of the area dredged 68.4% was frozen and had to be thawed by steam. The cost of drilling frozen ground for testing the gravel ranges from $1.73 to $2.36 per foot. The cost of hydraulicking 3,241,642 cu. yd. of gravel, with a total of 538,905 twenty-four hour miner's inches of water that gave a duty of 6.02 cu. yd. per miner's inch was 12.6c. per cu. yd. The total area of bed-rock cleaned was 126,057 square yards.

Driving a tunnel beneath the English channel to connect England and France is a matter once more being agitated in England. Two important, though conflicting, considerations are being advanced: The advantages of such a tunnel on one hand, and the risk of having such a means of communication in the event of a war. Those favoring the tunnel insist that should peace last a hundred, or even fifty years, after the close of the present War it would fully justify the construction of the tunnel, and in any event, there is no doubt that the advance in scientific knowledge would make it possible to hold such a means of communication open against any enemy.

'Human moraines' is the term applied by an English writer to the great piles of placer-tailing he saw in the diggings of the Klondike and the Yukon goldfields. It seems not inappropriate.

Flotation of Molybdenite

By Stuart H. Ingram

During some recent work on molybdenite ore a flotation-machine was developed differing from any that have been described, and while its field of usefulness is limited it has some interesting features. The ore contained 10% of molybdenite and small amounts of copper and iron sulphides in a gangue of quartz and calcite. The work undertaken made a clean concentrate necessary, so attention was directed to experiments on 'skin flotation,' as it was hoped that, owing to the flaky nature of molybdenite, it might be floated preferentially.

A test-machine was built; it consisted merely of a small spitzkasten one foot square at the top, an iron plate of about the same size, and a tub for catching the concentrate. Two opposite edges of the plate were turned up half an inch to form a wide launder, one end of which rested on the back edge of the spitzkasten in such manner that when the plate was inclined at about ten degrees from the horizontal, and the spitzkasten filled, the lower edge of the plate just penetrated the water's surface. The ore was mixed with oil and water and fed by hand along the upper edge of the plate. The irregularity of hand-feeding caused ripples at the point of entering the spitzkasten, and this undoubtedly sank much molybdenite, but still the results were encouraging enough to justify the construction of a larger machine on which the feed could be better regulated and distributed across the plate.

While experimenting, the best results were obtained when the pulp was very thick, but the thick pulp gave trouble through banking up on the plate. On the new machine the plate was suspended and given a reciprocating motion at right angles to the direction of flow by means of a shaft and eccentric. The results were better than with the first apparatus, with the stationary plate, but still left much to be desired. No matter how thin the sheet of pulp on the feed-apron was kept, some particles of molybdenite remained below the surface of the water during the entire transit across the plate, and on arriving at the spitzkasten they sank with the gangue. Riffles across the plate were tried, and while the eddies then formed brought some particles to the surface they sank enough of those already floating to nullify the effort.

I then tried riffles up and down the plate, or parallel to the flow of pulp, my idea being that the submerged particles would be thrown against the riffles by the motion of the plate and would eddy to the surface, where those with an oily coating would float. It worked beautifully. The riffles were spaced about two inches apart, breaking the plate up into a series of channels. Down the centre of each of these the molybdenite collected in a black streak forming a decided contrast in color with the brownish gangue, which seemed to hang close to the riffles, giving the table a striped appearance. Arriving at the placid surface of the spitzkasten the molybdenite floated out across it with considerable speed, the flakes in front apparently pushed on by those coming after. It was not necessary to use jets of water or any other means to give a forward motion to the surface film.

The concentrate flowed over the lip and was conducted in a launder to a settling-tank while the gangue was discharged through the spigot. As the feed was a thick pulp a water-line was connected to the spigot so that the tailing could be diluted sufficiently to flow readily in the discharge-launder.

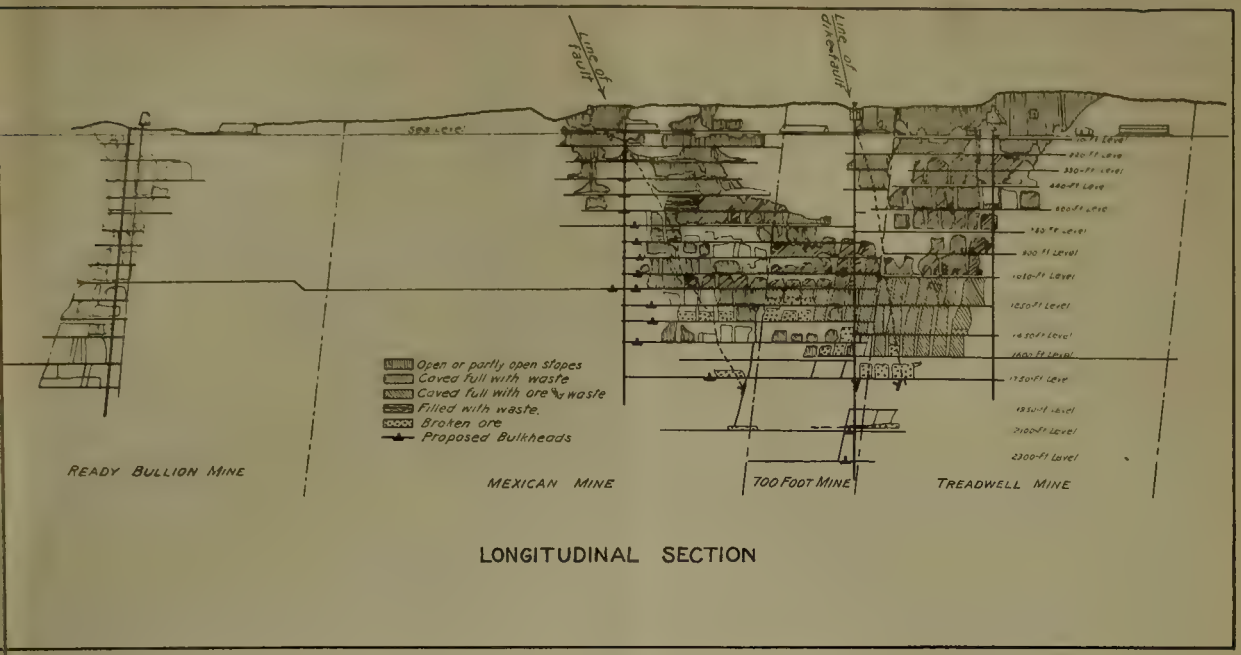
With care in regulating the feed, amount of oil, kind of oil, and size of spigot-opening, a concentrate was obtained that assayed 80% MoO_3, or 89% molybdenite. The copper and iron sulphides were eliminated by a proper selection of oil, but I believe they could have been floated had that been desired. The machine had its weak points, for it did not do well on slime and the ore needed several treatments to ensure a high recovery. But on sand between 40 and 150-mesh, it did excellent work—a recovery of over 90% was reached. It worked best on a classified feed where the grains were of about the same size.

I believe the idea of placing riffles at right angles to the motion of the table as described is patentable, but as there seems to be plenty of patents on flotation processes and machines—also sufficient litigation—I prefer to give it to the profession and hope there may be some who will find it useful.

THE rise in the price of aluminum to three times its normal quotation has led to a series of experiments being made with a view to recovering the metal heretofore lost in the form of chips, in machining aluminum castings in automobile factories. Although only 60% of the metal recovery is commercially possible, the preventable loss is of considerable magnitude. In re-fusing the scrap metal two methods are employed. In the one the chips are kept just above the fusion-point, the globules being made to coalesce by hand puddling. This smelting is done in an iron pot heated by oil. The other method is by the use of a flux that dissolves the dirt, skin, and oxide, on the surface of the chips, producing clean globules that can unite. The flux used consists of 85% common salt and 15% fluorspar (20 to 30% of the weight of the chips) mixed with the chips before charging. This is done in a graphite crucible, as a much higher heat is required than in the former method.

A MAGNESITE DEPOSIT is being worked in Italy that is said to contain over 1,000,000 tons. The analysis of this ore is said to run: magnesium carbonate, 88.11 to 90.03%; silica, 2.06 to 3.4%; lime, 2.68 to 3.34%; and iron oxide, 1.60 to 2.30%. The material is made into refractory brick, and has replaced the magnesite formerly obtained in Greece and elsewhere.

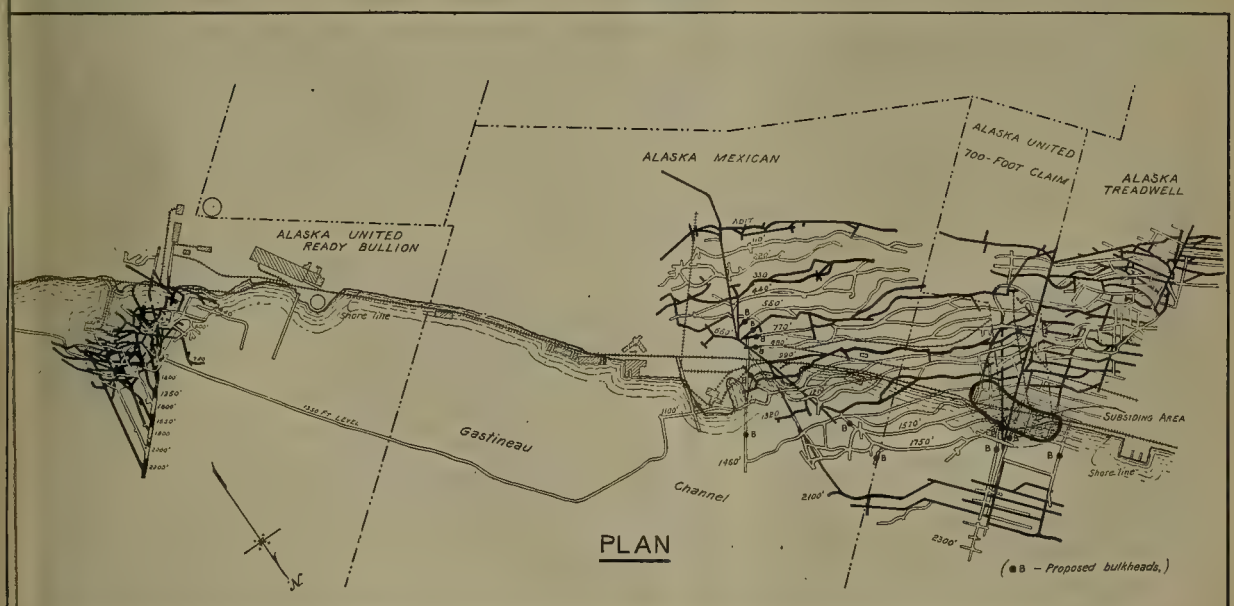
PIG-IRON PRODUCTION of Australia is now at the rate of 300 tons daily, this being the Broken Hill Proprietary's output. This is not the maximum demand of the Commonwealth.



LONGITUDINAL SECTION

The Subsidence in the Alaska-Treadwell Mines

For many years the gold mines on Douglas Island, Alaska, commonly known as the Alaska Treadwell group, have been recognized as being among the important gold mines of the world. The orebodies are of huge size and mining operations have been conducted on a commensurate scale, but by a method that has differed somewhat from that adopted in the exploitation of other large lodes. This variation of mining method has been the result of economic necessity rather than engineering choice, for the ore of the Treadwell mines is of low-grade. The official report issued July 31, 1916, gives the total amount of ore crushed to date by all the companies of the group as 26,464,047 tons; the yield per ton, $2.37; the mining and milling cost, $1.42 per ton, including the operating cost of 95 cents per ton; and the dividends declared 80.5 cents per ton.



It is obvious that mines producing ore of a tenor so low as that at Treadwell require high-class management, and the adoption of methods of mining and metallurgy that will reduce costs to a minimum. The mines are situated on Gastineau channel, which separates Douglas Island from the mainland of Alaska. The dip of the formation and of the included ore-deposits is north-east, and the lower workings of the mines are vertically beneath this body of salt water.

The rocks enclosing the orebodies or adjacent to them are greenstone, slate, and soda-syenite. These rocks, when large excavations are made in them, generally stand fairly well without support. For many years the greater part of the ore was mined in large open pits called 'glory-holes.' Gradually, as the years passed, these open-cuts became increasingly deeper, shafts were sunk, and levels opened, far below the bottom of the surface workings. Glory-hole mining is one of the least expensive methods of winning ore, particularly from large orebodies, and it was found to be well suited to conditions on Douglas Island during the greater part of the year, but when the open-cuts became too deep to make this system safe or desirable, underground methods had to be adopted that would still admit the removal of a large tonnage of ore at the minimum cost. To follow the usual custom of square-set timbering, as practised at many Western mines, was prohibitive because of the cost, and the shrinkage method followed by filling with waste-rock from the surface was not undertaken for a similar reason; so, after trying various methods a satisfactory system was evolved whereby a large tonnage could be mined safely and cheaply, and at the same time permit the recovery of the greater part of the ore. This system can be outlined thus: the opening of levels from the shafts, the removal of the ore by overhand stoping, and the leaving of pillars of ore, both vertical and flat, to support the walls and the back of each stope. The vertical pillars, reaching from wall to wall, were left at intervals of 100 ft., measuring from centre to centre. The flat, or sheet-pillars, were horizontal or nearly so. When a stope was being cut, the miners stood on broken ore, only enough being withdrawn at the level below to keep the men within reach of the back, which was arched to reduce the tendency to cave. Ore was stoped to a maximum width of 250 ft., and in places was removed for a width of 160 ft. along a horizontal distance of 300 ft. The shape and size of a stope was controlled to a great extent by the value of the ore—the mining stopped when the ore no longer yielded a profit.

Unfortunately, when the ore was drawn from the stopes the excavations were not filled with waste. As a natural result of this system of mining an enormous pressure gradually developed on the hanging-wall side of the stopes, and this pressure became concentrated upon the pillars left to support the ground. During the last five or six years this hanging-wall pressure has become increasingly evident, and numerous caves have occurred in the various stopes, some of them of a disastrous nature. Not only was the immediate neighborhood of the caving badly shaken, but the terrific concussions, known as 'air-blasts,' caused damage at a distance, and frequently made themselves unpleasantly manifest at the surface.

Some of the earlier caves proved to be rather an advantage than otherwise, as a lot of waste rock from the walls and from the surface fell into the open workings filling some of them more or less completely, thus insuring against further serious caves at that locality, but where this broken filling did not break down into lower stopes the caving continued from time to time with increasing and alarming frequency.

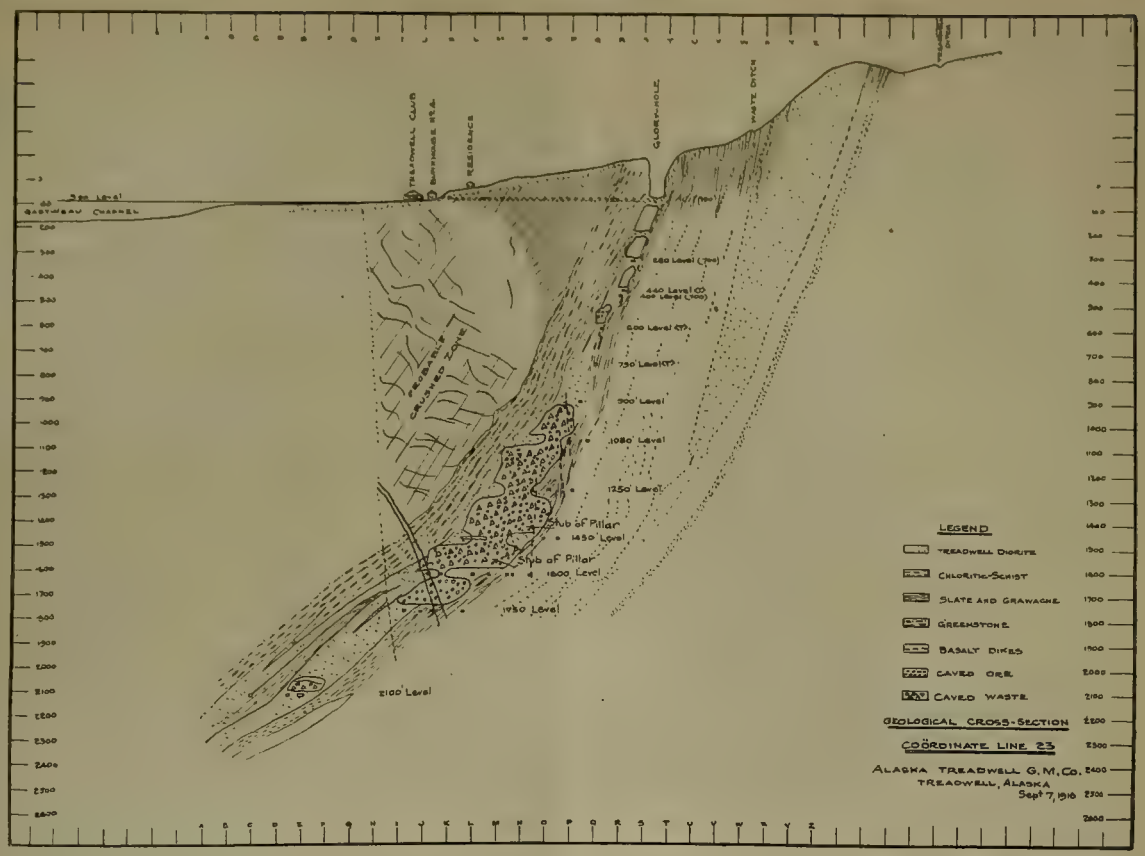
The following description of a large cave is abstracted from a recent official report* issued by the company.

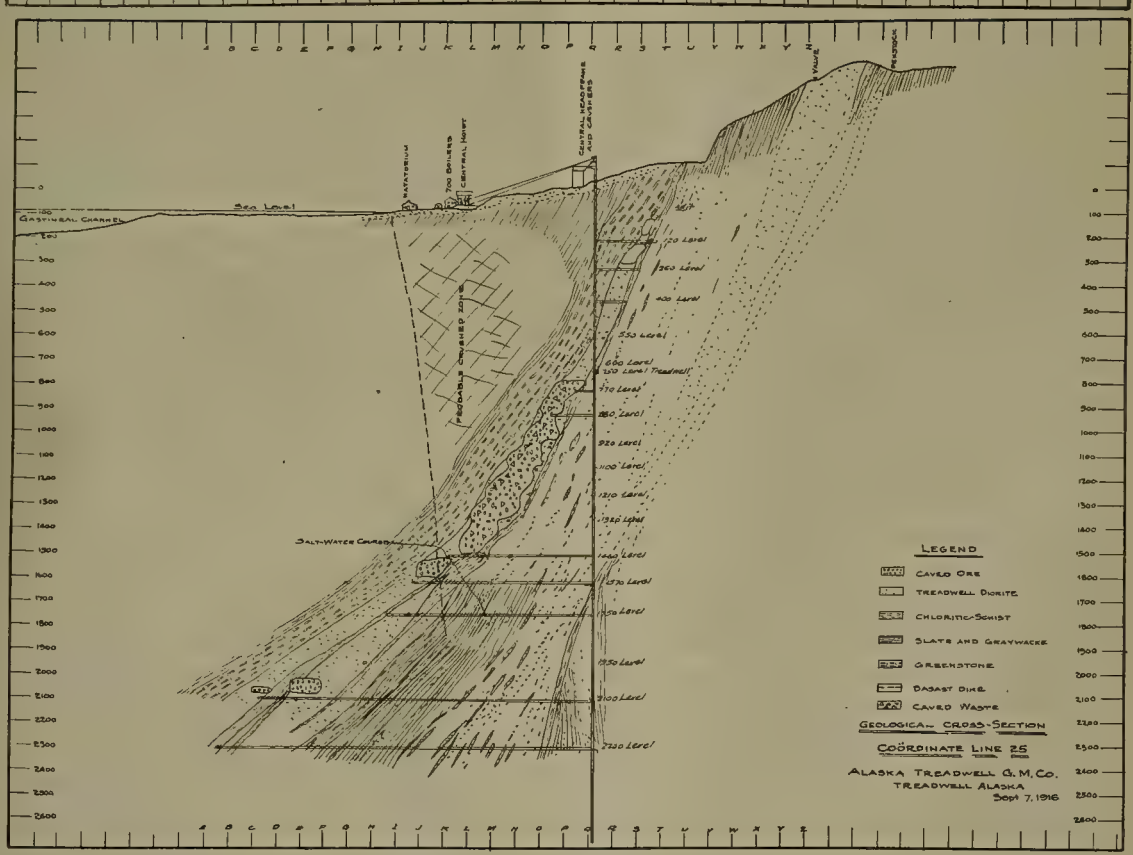
"On June 15, 1915, the roofs of No. 2 and 3 south-vein stopes, above the 900-ft. level, caved-in, taking also the bottom of No. 3 and 4 north-vein stopes on the 750-ft. level. The pillar between stopes 2 and 3 north vein, 750-ft. level, no doubt went as well, as the cave reached to the bottom of the east end of the glory-hole, taking in all the loose rock, all our waste-dump, some slate in place off the foot-wall, and a little ground off the hanging wall. On July 2, the top of No. 2 stope, south vein, 750-ft. level, caved, and the stope filled itself with broken rock that had come down with the previous cave. This last cave left the floor of No. 6 level, above No. 2 south-vein stope, badly cracked, and this country now has the appearance of resting on the caved rock beneath."

The report proceeds to state that the first cave occurred between shifts, and no serious consequence ensued, though the air-blast was terrific. Both of these caves shocked the whole mine to a noticeable extent and a number of cracks have appeared in different places. One of these shows for 150 ft. on the surface, crossing a ditch above the glory-hole. There was a vertical movement of several inches along this crack, and all the water then flowing in the ditch disappeared in the crevice, necessitating the construction of a flume. Another crack appeared near the Central shaft on the adit-level, into which the water remaining in the bottom of the ditch disappeared. The cracks in the 440 and 600-ft. levels, near the Treadwell shaft, are of more consequence and may have an important bearing on the future of the mine. In fact, owing to these cracks, plans for sinking the Treadwell shaft to the 2100-ft. level have been abandoned. The No. 4 stope, north vein, on the 600-ft. level, is carried up to the 440-ft. level and is within 30 ft. of the shaft, between these two levels, and for this ground there is reason to fear. To forestall any further movement there, connection was made from the 330-ft. level to the bottom of No. 9 pit at the surface, and through this connection waste-rock will be drawn to fill the Ore stope, between the 330 and 440-ft. levels, and from this stope the rock will continue downward and fill No. 4 stope on the 600-ft. level.

Quoting the report: "On July 9 the bottom of the 1210-ft. Mexican level, over stopes 2 and 3, caved. This

*'Report of the President to the Board of Directors,' October 20, 1916.


Treadwell Glory-hole
Waste Ditch
Treadwell Cave
Bunkhouse No. 4
Residence
Gastineau Channel
300 Level
Probable Crushed Zone
440 Level (Top)
600 Level (Top)
750 Level (?)
900 Level
1080 Level
1250 Level
Stub of Pillar
1450 Level
Stub of Pillar
1800 Level
1950 Level
2100 Level
LEGEND
Treadwell Diorite
Chloritic-Schist
Slate and Grawacke
Greenstone
Basalt Dikes
Caved Ore
Caved Waste
GEOLOGICAL CROSS-SECTION
COÖRDINATE LINE 23
ALASKA TREADWELL G. M. Co.
TREADWELL, ALASKA
Sept 7, 1916


Natatorium
700 Boilers
Central Hoist
Central Headframe and Crushers
Gastineau Channel
300 Level
Probable Crushed Zone
320 Level
360 Level
400 Level
550 Level
600 Level
650 Level Treadwell
770 Level
880 Level
920 Level
1100 Level
1310 Level
1350 Level
Salt-Water Crosscut
1530 Level
1750 Level
1950 Level
2100 Level
2250 Level
LEGEND
Caved Ore
Treadwell Diorite
Chloritic-Schist
Slate and Graywacke
Greenstone
Basalt Dike
Caved Waste
GEOLOGICAL CROSS-SECTION
COÖRDINATE LINE 25
ALASKA TREADWELL G. M. Co.
TREADWELL ALASKA
Sept 7, 1916

was no surprise, as we have been for some time using every effort to hold up this portion of the Mexican mine. There were no serious consequences and there will be no interference with any of the Mexican operations."

These repeated caves in the underground workings began to show their effects with increasing distinctness at the surface, where a number of cracks developed. These became more pronounced as time went on, and an alarming subsidence of the ground became noticeable near the boundary between the Alaska Treadwell and the 700-ft. mines.

On July 27, 1916, a large crack was found in the north wall of the Central hoist-building and other evidences of disturbance began to be observed in various structures at the surface. Numerous cracks appeared in a concrete retaining-wall of the 700-ft. mill. Subsidence continued and on August 29 the line-shafting of the mill had separated over two inches. The foundations of the buildings and machinery settled, cracks opened and closed in the floors, and other evidences of subsidence became numerous during the summer of 1916. That some of these cracks appearing at the surface extended to points far below was proved by one developed 50 ft. east of the Treadwell shaft. This crack was in greenstone and was four or five inches wide. A stone dropped into it could be heard for some time rattling against the walls of the fissure as it fell. It was thought to extend at least to the 440-ft. level. When first noticed, in June 1915, this crack was but a quarter of an inch wide.

While there are many evidences of horizontal movement and of subsidence in places at the surface, and the Treadwell shaft has been pushed out of line in several places, the most significant evidences of movement are to be seen on the various levels of the mine near the Treadwell shaft and for some distance from it. Workings have caved, some places have been rendered inaccessible, and others are likely to become so. The 750-ft. level has been the scene of disastrous caves, and for 100 ft. from the Treadwell shaft all drifts except one are blocked, and constitute what one miner has described as a "wild-looking country." It was the bottom of this level that dropped in 1915, causing the bottom of the glory-hole to sink. Then part of the caved rock that reached the 750-ft. level flattened out in the stope like the lower end of a large rock-slide from a mountain-side; large boulders rolled into the drift, and four cars standing over the ore-pocket at the station were blown into the shaft. The force of the air-blast "shook the country around Treadwell like a small earthquake"—so says the report.

Underground, disturbances have taken place as low as the 1600-ft. level, and cracks have appeared in the 1750-ft. level, so that it will be seen that the movement of ground is by no means confined to the region of the upper workings of the mine.

What may prove to be much the most important matter in connection with this caving is the well-founded fear that the disturbance has not been confined to the area about the Treadwell and 700-ft. end-line, but may have extended north-eastward into the hanging-wall region, and underneath the water of Gastineau channel. The caves in the mine are the direct result of mining millions of tons of ore in large blocks while leaving insufficient support in the form of vertical and horizontal pillars. Over 340,000,000 cubic feet of rock has been excavated. This naturally has resulted in a general subsidence over a large area and the formation of an intricate system of fissures on the hanging-wall side of the ore-deposits. If these cracks extend upward to the bottom of Gastineau channel, as now seems probable, and further movement ensues on the planes of these fissures, the consequence would be calamitous. There is one serious item of evidence bearing on this subject that is disquieting, to say the least, and that is that salt-water has made its appearance in the workings at a number of places, although not, as yet, in large quantity. Natural fissures—those that have been in existence for a long period are usually filled with clay or some other mineral that may have been deposited from solution, sealing the crack and rendering it water-tight; not so, however, a crack recently made, such as those resulting from conditions due to causes above described. Cracks of this description are likely to afford free passage to water and if they become numerous, under the hydrostatic head that would develop in the lower levels—1400 to 1700 ft.—the water would be likely to enter the mine at a rapid rate and under conditions that probably could not be controlled.

Following are some of the conclusions reached by the company's engineers in their investigation of the causes of the subsidence, as published in the report of Livingston Wernecke, geologist for the company:

"The surface subsidence between the Mexican and 700-ft. mills, which appeared in 1913, was preceded by caving of the stopes in the Mexican mine. A basalt dike with a decided fault, which cuts this ground diagonally to the strike of the slates and orebody, has formed a line of weakness by which the caving reached the surface. No undiluted salt water reaches the mine in this vicinity. The salt water seems to be diluted with an equal volume of fresh water, and to have traveled some distance through water courses.

"The surface subsidence in the vicinity of the Treadwell Club, Natatorium, Central Hoist, and 700-ft. mill is connected with the movements in the immediate bedrock.

"The stopes in the Treadwell mine below this subsiding area are full of caved ore and caved waste, as far as can be determined by inspection.

"Underground investigations show that all pillars in the vicinity under consideration have been crushed. Some on the 1250 and 1050-ft. levels were mined so that they would cave. Those at 1450 and 1600-ft. caved without assistance, and some of those at 1750-ft. crushed while the stopes were full of broken ore.

"A reasonable conclusion from the above facts is, that the weight of overlying rock has broken the hanging

wall, and it is resting on the caved ore and caved waste. This is particularly likely to be true along the flat dips, and at the change from a steep to a flat dip, which forms a sag in the hanging wall. Part of the waste is from the glory-hole, and part from the hanging wall.

"Air-blasts, or the caving of rock with explosive violence from some internal or molecular strain, have produced a peculiar caving phenomenon from the backs of some stopes and faces of some drifts, but undoubtedly is not the cause of the intense shattering of pillars.

"The backs of cross-cuts and drifts are supported by an invisible arch-ring in the rock, the shape of which depends on the elastic properties, broken or fractured condition of the rocks, the dip of the formation, and weight of overlying rock. The amount that the axis of this arch-ring is inclined from the vertical depends on the dip of the formation.

"The backs of the stopes are supported by an invisible vault, which depends on the same properties of the rock as the above arch-ring. The inclination of its axis, also, depends on the dip of the formation.

"If all the stope-pillars are shattered, it is reasonable to believe that the fissile and broken condition of the slate, the steep and variable dip, the variable elastic properties of slate, diorite, and greenstone, and the cross-cutting dike-fault make an immense vault to span the entire area an impossibility.

"The axis of this theoretical cone will be inclined approximately 20° from the vertical toward the north-east, and will intersect the 700-ft. dike-fault. It is reasonable to conclude that the slate has broken along this cross-cutting line of weakness and reached the surface, where the subsidence has taken place.

"The 700-ft. mine dike-fault, which is similar in every way—except the one difference mentioned below—to the Mexican dike-fault, was first noted in May 1913 on the 990-ft. level of the 700-ft. mine.

"A severe cave followed in October 1913 in the stopes in the vicinity, from 1320 to the 880-ft. level. This was the origin of the present subsidence, which, after being augmented by further caving in June 1915, in the Treadwell mine, reached the surface in July 1916.

"The 700-ft. dike-fault differs from the Mexican dike-fault in that undiluted sea water flows along or near it, and enters the Treadwell mine on the 1600-ft. level."

The management of this group of mines has been watching the result of the earth-movements and the inflow of water, and the volume of the mine-water is being measured carefully and systematically. Many analyses have been made to determine what proportion of the water is entering from the Channel. Investigations have led to the belief that comparatively little sea-water entered the mine before 1916, but during that year the inflow of salt water is estimated to have reached 39 gallons per minute. Whether or not this flow will become greater remains to be seen, but it is feared that it may. Several lines of weakness cross the formation and the orebodies, in the form of dikes and faults, and it is from these that the greatest danger is apprehended.

The consensus of opinion of the engineering staff of the mines is that further drawing of caved ore will cause more surface subsidence, and a probable increase of salt water, but if the drawing proceeds with caution, and all indications are carefully watched, no disastrous flood of salt water will follow.

Four preventive measures have been suggested: (a) Bulkheading each level near the Combination shaft, drawing the available caved ore, and letting the upper part of the mine fill; (b) Filling all open stopes above the 1750-ft. level with tailing, to prevent further caving; (c) Prospecting for the dike-fault at the surface, and building a coffer-dam or bulkhead to exclude all sea-water and fill it with tailing; and (d) Filling Gastineau channel 300 ft. or so from the present shore-line with tailing to exclude a part of the sea-water and prevent any possible flood from the Channel. The last is being done at present, and this, with careful drawing of caved rock should minimize the probable danger.

Although the quantity of water pumped from the Treadwell mines is small as compared with some mines, 27% of it is salt water from Gastineau Channel. This, with the surface subsidence near the shore along a line of structural weakness, is sufficient to constitute a menace if the drawing of ore had continued at the rate of 1,000,000 tons per year. This condition has been eliminated temporarily by decreasing the amount of ore drawn.

F. W. Bradley, president of the several companies, in his official report to the boards of directors of the Alaska Treadwell Gold Mining Company, the Alaska Mexican Gold Mining Company, and the Alaska United Gold Mining Company says: "If the properties are consolidated; if the orebodies continue down to the 4200-ft. level, of past average size and value; if the temperature at the 4200-ft. level does not exceed 95° F.; and upon the further assumption that stoping can be done on the basis of leaving 50% of the orebody as pillars and of finally extracting 50% of the pillars so left, the consolidated property should, beginning at the end of the year 1919 and for 16 years thereafter, be able to mill 1,750,000 tons annually at an average profit of 75c. per ton."

The Combination shaft, formerly the Mexican No. 2 shaft, now enlarged to five compartments, is being sunk, and is now down about 2100 ft. Mr. Bradley advises that this shaft be completed to the 3600-ft. level and be equipped with a new electric hoist capable of hoisting 5000 tons per day from the 4200-ft. level. He suggests that the Combination shaft should be equipped with twice the pumping capacity of the pumps at present in the Treadwell shaft, the latter to be held in reserve. The Combination and Central shafts should have all connections with the old workings closed by means of bulkheads. The Combination shaft would then become a down-cast and the Central shaft an up-cast for all future ventilation.

Diamond-drill holes sunk to a depth of over 500 ft. below the 2300-ft. level indicate the continuance of ore to that depth at least.

Flotation at Cripple Creek

The Vindicator Consolidated Gold Mining Co. has in successful operation a 300-ton flotation test-plant, employing the M. S. apparatus, treating mine and dump ore. The report for 1916 gives the following results from December 1 to the middle of January:

Heading, per ton	$1.985
Tailing, per ton	$0.410
Recovery, per cent	81.20
Concentrate, per ton	$19.34
From January 1 to 9 results were:	
Heading, per ton	$2.26
Tailing, per ton	$1.38
Recovery, per cent	84.40
Concentrate, per ton	$20.66
From January 9 to 15, on crude ore:	
Heading, per ton	$5.40
Tailing, per ton	$0.375
Recovery, per cent	93.10
Concentrate, per ton	$40.25

The general manager, Irving T. Snyder, considers that these results are satisfactory, and the enlargement of the plant will follow during 1917.

Wilhelm Merton

In the recent death of Wilhelm Merton, founder and chairman of directors of the Metallgesellschaft of Frankfort-on-Main, Germany lost one of its foremost manufacturers and financiers. With his father, Ralph Merton, Wilhelm became a partner, early in the seventies, in the Frankfort metal firm of Philipp Abraham Cohen, which was converted in 1881 into a limited liability company called the Metallgesellschaft, with a capital of £100,000, afterward raised to £1,000,000. This organization with its subsidiary and allied companies, the Metallbank, the American, Australian, and African Metal Companies, and various Swiss, French, and Spanish enterprises has controlled a large part of the metal resources of the world. The War has lopped off some of its limbs, but in 1913 it was estimated that, apart from the private fortunes of the capitalists at the back of the organization, the capital invested in the concern was not less than £10,000,000. The English business of the Mertons was done through the firm of Henry R. Merton & Co., Ltd., of London. Last year the proprietary interests of this firm and the Frankfort enterprise were entirely severed by an exchange of shares, and the London Company now is wholly British-owned. Wilhelm Merton had been engaged on war work for the last two years, and it is stated that he co-operated actively in the drafting of numerous regulations dealing with the economic management of the War, and that "his advice caused many mistakes to be avoided," although his name was never publicly mentioned in connection with his work. In fact, the practice of self-effacement appears to have been one of his most striking characteristics, and in business circles he was very little known except as the head of three great metal firms, the Metallgesellschaft, the Metallurgische Gesellschaft, and the Gesellschaft für Metallwerte of Bale. He was also a director of the Frankfurter bank and of the German Gold-Silver Assaying Company.—*The Daily Metal Reporter.*

Alaska Gold

In April, 1915, Alaska Gold sold at 40¾. The convertible bonds, of which there are two issues of $1,500,000 each, sold up to 160. In January the stock declined to a new low point of 8¼, while the bonds are down to 80.

No unusual developments have transpired at the property, beyond those which are currently set forth in the monthly statements. Combining these reports for the year 1916, we find that Alaska Gold treated 1,888,869 tons of ore which had a gross value of $1.23 per ton. Deducting losses in the mill tailings of 22 cents per ton, there is found to have been $1.01 per ton net recovery for the year. This compares with 93 cents per ton in 1915.

Reducing these figures to a theoretical income account, we have the following for the 12 months of 1916:

Net gold recovered	$1,907,757
Estimated cost (71 cents per ton, as in 1915)	1,341,096
Net profit	566,661
6% interest on $3,000,000 bonds	180,000
Surplus	381,661

Of course it will be seen at once that after such development expenditures as have not been charged into current account, there is a very small balance left for the 750,000 shares of stock. In this connection it may be mentioned that in the year 1915 the so-called "deferred charges to operations" amounted to $338,039. A similar expenditure for development this year would reduce surplus earnings close to the vanishing-point.

Alaska Gold represents in cost of property and development an expenditure of close to $11,000,000. At $40 per share the property had a selling-value of over $30,000,000. Today it is selling for $9,000,000, or $2,000,000 less than has been invested in it.

The promoters firmly believed from experimental mill-runs and drill-hole assays that the ore would run not less than $1.75 per ton, or $1.50 after losses in mill treatment. Actual results to date show a net return of $1 and this difference of 50 cents a ton, small as it may seem, spells either the success or failure of the whole enterprise.—*Boston News Bureau.*

IRON MONEY (small coins) is now used in Germany and Austria. The problem of protecting the pieces from rust was solved by super-imposing a thin layer of zinc. The discs of metal, together with some zinc-dust, are heated at a temperature somewhat below that of the melting-point of zinc (433°). The resulting surface not only preserves the coins from rust, but also enables the die to be impressed without cracking the surface of the metal. This zinc-plated iron money differs little in appearance or weight from nickel coins.

Dry Placer Mining

By A. Maltman

To the Plomosa mines, 26 miles south of Bouse, Yuma county, Arizona, is due the credit of installing and operating a successful dry-placer plant on a large scale.

The ground is cemented conglomerate, 25 to 30 ft. deep. Although the main deposit lies on and near the bedrock, the whole mass carries gold from the surface down. It will average $1 per cubic yard.

The reduction plant is 75 ft. above the ground to be worked. It consists of one Sauerman Bros. drag-line excavator, the bucket having a capacity of 1½ cu. yd.; it is operated by one man and will dig and deliver 50 cu. yd. per hour. The power is supplied by a 125-hp. Bessemer oil-engine. This engine consumes 10 gal. of 24° fuel-oil per hour at a cost of 7c. per gal. at the mine.

The contents of the drag-line bucket are dumped into a bin 12 by 12 ft. Immediately beneath this bin is a reciprocating feeder that has an opening of 24 inches, and receives everything that comes along; care, however, is taken not to allow any boulders to enter. From this feeder, the material drops into a Williams chain-hammer mill, consisting of a cylinder about 48 in. diam. and 6 ft. long. The cylinder is provided with hard-steel gratings set $\frac{3}{16}$ in. apart to allow the pulp to drop through. This cylinder moves at 30 r.p.m.; in the centre of it, extending two feet beyond either end, there is a shaft 5 in. diam., to which is attached a number of hammers fastened by a chain of three links on a collar. This shaft revolves at the rate of 400 r.p.m. The material to be treated does not need to be crushed but disintegrated and separated from the gravel. At the opposite end an opening allows the waste to discharge. About 40% of the whole mass passes out of this end partly broken up. The remainder, which contains the gold, passes through the grating and gravitates to an elevator having a capacity of 50 tons per hour. This elevator delivers the pulp to a No. 12 Stebbins dry concentrator that rejects 80% of the pulp. The remaining 20% is conveyed to a small elevator and enters a No. 7 Stebbins concentrator, which produces a finished product of gold, lead, and iron. In order to still obtain a further separation, the concentrate is fed to a No. 4½ concentrator, which gives a final and clean product.

In the centre of the mill-building there is a belt-conveyor, 20 in. wide and 75 ft. long. This conveyor is so situated as to permit all of the waste material from the mill to drop on it and remove it out-doors. The three concentrators, belt-conveyor, elevators, and shaftings are driven by separate power, consisting of a 25-hp. International gas-engine, using distillate.

Several hundred feet from the tailing-pile, and on an elevation, there is another of the Sauerman drag-line dredging outfits operated by a 60-hp. Bessemer engine, which drags the tailing away to vacant ground. This is also run by one man, at the rate of 50 cu. yd. per hour.

The total cost of the whole operation is 15c. per yard. The plant was designed and built by the writer.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

OLD STEAM-BOILERS may be used as compressed-air receivers.

GOPHER BLASTING has been almost stopped at the Chino copper mine.

COARSE-ORE GRIZZLIES at Hurley, New Mexico, have openings 12 by 13 inches.

A 100-TON STEAM-SHOVEL, handling 2800 cu. yd. of overburden or copper ore in 10 hours, uses 7½ tons of coal.

LIME AND SODA-ASH solutions are good precipitants of salts in water used in boilers, and act as water-softeners at the same time.

GOLD-CONTENT of the Chino copper ore is low, and in assaying, four assay-tons is reduced to get a bead of convenient size for weighing.

HYGIENE is defined as the science of health and of its preservation; the science, study, and knowledge of the means of keeping well and in good health.

CYANIDE TANKS made from corrugated galvanized-iron sheets have been successfully used. They are inexpensively and easily built, but they are much inferior to red-wood.

GASOLINE is used by army surgeons in Europe for the first cleansing of wounds on soldiers. The 'gas' does not cause any special smarting, yet care must be exercised in its use.

AN ALLOY is the fusion of two or more metals into a compound. Two or more metals may form a mixture and still not be an alloy, if one metal is but mechanically held between the particles of the other.

HIGH-SPEED machinery requires bearings of the best quality. The bearing-metal must have a low coefficient of friction and must resist tendency to rise in temperature to a destructive point when under heavy service.

THE parcel-post has recently been utilized to make shipments of high-grade ores where other methods of transportation were unsatisfactory. It is well for shippers to know that this can be done at a reasonable price.

CHURN-DRILL SAMPLING errors are as follows: deviation of the hole from the vertical; breaking off at the point of drilling of a surplus of rich brittle material, thus giving a sample that is too rich; concentration of heavy minerals in the bottom of the hole, so that they are not reached by the bailer, or are recovered from the hole when it has reached a much lower depth where the rock may actually be barren; and caving of the rock from the sides of the hole.

THE NEVADA STATUTE requires that within 20 days from the date of location of a mining claim the boundaries of the claim must be defined by the placing of posts or monuments of stone at each of the four corners and at the centres of the side-lines of the claim. Ninety days are allowed within which to complete the location work.

EQUIPMENT for a charging (blasting) crew at an open-cut mine is as follows: springing-gauge, charging-sticks, pocket reflecting-glass, galvanometer, rheostat, blasting-battery, explosives, fuse, electric detonators, combination detonator-crimper, pliers, and punch, wooden mallet, large funnel, pocket-knife, wooden axe-handle, detonators, battery lead-wire, connecting wire.

LONG EXPERIENCE has demonstrated that broken rock passes most readily, without jamming, through raises (or winzes) when these cuttings have been made at an angle of about 50° with the horizon. When much steeper or flatter than this the rock is almost certain to jam, should the passage ever become filled completely and drawing off of rock be stopped for some time.

BABBITT, the accepted trade term for bearing-metal, is derived from Isaac Babbitt, Taunton, Mass., the first person of record to use a white-metal alloy as a lining for machinery bearings. In 1839 Babbitt conceived the idea of using an alloy made up of 4 parts copper, 24 parts tin, and 8 parts antimony. This was so successful that a gold medal and $20,000 was awarded him by Congress in recognition of his service to American industries. Prior to that time brass or bronze bearings were used.

THE FLASH-TEST for oil is determined by placing a quantity of the oil to be tested in a shallow dish and setting a Bunsen burner beneath it. The bulb of a thermometer of a special make is then immersed in the oil and a lighted candle passed around the edge of the dish. When a flash follows the ignition of the vapor rising from the heated oil, the temperature of the oil is observed—the 'flashing-point' of the oil. If the heat is raised to a higher point the oil is likely to burst into a blaze. This latter is the fire-test.

NOTWITHSTANDING the fact that large numbers of new men have been engaged, and that 21 men were killed in its Pennsylvania mine, the Anaconda company reports a 23% reduction in accidents at its Butte mines during the first half of 1916. The principal reason for this reduction is that the company's Bureau of Safety has had the heartiest co-operation of foremen and shift-bosses, and that through their efforts the men are becoming educated to take care of themselves—to do things the safest instead of the easiest way. Many of the worst offenders in breaking rules are old-timers.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

SUTTER CREEK, CALIFORNIA

Safety Association Formed.—Central Eureka, Old Eureka, Bunker Hill, and Keystone Mines.

At the suggestion of Edwin Higgins, formerly Chief Mine Inspector of California, a meeting of mine managers has been held at Sutter Creek, at which plans were made for perfecting the organization of the Mother Lode Mine Safety Association. Mr. Higgins has been conducting a safety campaign in this region for some time, and has offered various suggestions, which the mine-owners are adopting as far as practicable. The application of safety work was discussed at the recent meeting, also the general needs of the mining community, such as adequate hospital service, better housing of miners, as well as first-aid and mine-rescue training. Some attention was also given to the advisability of having public safety meetings, to include music, addresses, and moving pictures. Another meeting will soon be held to complete the organization, after which monthly meetings will be held. Foremen and others in authority at the mines are taking an active interest in this movement, and it is thought that these meetings will do much to promote co-operation between the various companies in matters pertaining to safety and efficiency.

At the Central Eureka mine, the 2500-ft. cross-cut, driven for filling, has cut some good-looking ore within the past week. The orebody appears strong. The shaft station has been completed at the 3250-ft. level, and driving is progressing well on the ore found in sinking.

At the Old Eureka mine it has been found that the size of the shaft below the 1600-ft. level is less than that so far retimbered, there being but one compartment from that level down, so that the time required for unwatering will be less than was anticipated. Some difficulty is experienced in keeping the shaft crews employed near the various levels supplied with timbers, as there is only one small skip in use, but this difficulty will be overcome when the new engine and head-frame can be put into service. Ore-bins are being built on the new frame, and it is understood that the electric motors will be delivered within a few days. Contracts have been let for erecting the large platform from the engine-room to the new head-frame, over the shaft, and the space beneath will later be filled in by means of the waste to be hoisted by the newly installed equipment. Another mining carnival, similar to the Eureka carnival held here last year at the time of the sale of this old mine, but far more elaborate, is to be held here about April 1.

During the past week the Bunker Hill Consolidated Mining Co. has made public an interesting statement concerning the operation of its property at Amador City for the six months ending December 31, 1916. During that period the 40-stamp mill was operated 127 days, crushing 27,370 tons of ore, averaging $4.014 per ton, excluding returns from tailing treated by another company. The net cash value of bullion produced was $33,641; concentrate, $77,225; while there was derived from tailing, interest, and rental of property the sum of $2776. The actual cost of mining, milling, insurance, taxes, salaries, and general expense averaged $3.722 per ton of ore treated. Mining cost $81,472 and milling $8577. The company spent on construction an additional $24,237. This included 225 ft. of concreting in the shaft to replace the heavy timbers heretofore used just below the collar, the erection of concrete ore-bins on the surface, and a large addition to the mill, as well as the building of a new road. The company discontinued its dividends in September, partly as a result of the strike, $15,000 (half the usual semi-annual amount) having been disbursed in dividends since July 1, 1916. The surplus in the treasury has been reduced from $43,358, six months ago, to $15,867 on January 1, 1917. The mine is now well equipped for economical work, and after the shaft has been sunk to the proposed depth of 3000 ft. and levels opened, it is confidently expected that the Bunker Hill will exceed its record, which now shows 123 consecutive monthly dividends paid its shareholders prior to the end of last September. E. Hampton is superintendent and R. Christiansen, foreman.

The semi-annual report of the Keystone Mines, to January 1, 1917, shows a total of 21,260 tons of ore milled during the period. Forty stamps were in steady operation, that is, from July 1 to December 28, and from December 28 to the end of the year. During these times the bullion recovered was worth $10,235; 771 tons of concentrate returned $48,437, while $499 was derived from the sale of base bullion. Freight and smelter charges were $9257, reducing the net realization to $49,915, or an average of $2.34 per ton of ore milled. The company's disbursements are segregated as follows: mine account, $74,000; corporation and license tax, $117; interest on money borrowed, $1017; secretary's office, including manager's salary, etc., $1654. The present indebtedness of the company for money borrowed is $20,423. In the past six months the shaft has been re-timbered from surface to the 400-ft. level, 80 full sets of 18 by 18-in. timber having been put in place. In repairing the 15-in. air pipe-line, 433 ft. of new pipe was used. Two new 3-ton skips have been put into service, and necessary repairs made to the hoist-drums, so that the entire plant is now in good physical condition. Work of extracting ore is in progress on the 900, 1000, 1200, and 1400-ft. levels. At 1800 ft. the station is nearly completed, and the face of the cross-cut is now 150 ft. from the shaft. Large reserves of low-grade ore are blocked-out on the four levels from which ore is now being taken, and the ore-bins now hold about 1104 tons. C. R. Downs of Sutter Creek is manager, C. L. Culbert of Jackson, secretary, and B. I. Hoxsie, foreman.

Publicity by Amador county companies is increasing.

DEADWOOD, SOUTH DAKOTA

Review of Recent Developments in the Black Hills,

Higher prices for silver have stimulated prospecting for ores of that metal, and some of the old producers have been examined. The Shamrock, on West Strawberry gulch, near the Puritan, has lately yielded samples assaying as high as 118 oz. silver from a small seam. The owners intend to continue development, for this and similar stringers, together with a considerable quantity of lower-grade material, are believed to form the basis for milling operations.

Development planned for the Minnesota will consist of exploration of the Unionville vein, in the western part of the property. This outcrop has yielded consistently good assays, but has never been more than casually developed. An adit has been driven to intersect it, but has not yet penetrated the ore. It is now proposed to do work in this adit which has long been planned, but which has been deferred for various reasons.

At the annual meeting of the Deadwood-Heidelberg Mining

Co. the following directors were elected: H. S. Vincent, John Treber, A. T. Roos, Banks Stewart, I. Salinsky, Grant Ourth, and Jacob Goldberg. Superintendent Roos reported that work was progressing uninterruptedly on a connection with the surface, whereby it would be possible to expedite operations and cheapen the mining of ore from the west vein. This connection will also serve to ventilate the long cross-cut. As soon as it is made it is proposed to commence shipments of cyaniding ore to the Golden Reward mill, at Deadwood. Developments during the year were stated to have been satisfactory and encouraging.

The American Mining Corporation is the name of the new concern, backed by Iowa and Chicago capital, that has taken over the Alder Creek property and the Bismarck mill, at Flatiron. Under the management of F. C. Bowman the mill has been overhauled and put in commission, at part capacity.

St. Louis backers of the Hill City Tungsten Production Co. are endeavoring to liquidate the indebtedness and put the operations on a substantial footing. Money has lately been received at the Hill City office to take care of a good portion of the debts, and enough more is promised to pay off the balance and leave a good working surplus. A complete change of management has been effected at Hill City. The mill is working at part capacity on tin ore.

Tungsten production of the Black Hills for 1916 came almost entirely from the Homestake and Wasp No. 2, both of which companies erected and operated 20 to 25-ton plants for concentration of the ore. Some small shipments were made from Hill City and Spokane, and discoveries that promise well were made at several points. One of the most important of the discoveries was made in Harney canyon, 4 miles south of Hill City, where a large pegmatite dike, said to average 1.25% tungstic oxide over a wide face, was found and located by W. L. Faust and others. Noteworthy finds were made in the vicinity of Deadwood, where replacement deposits in the Cambrian, similar to the productive deposits in the Homestake and Wasp No. 2, were uncovered, one of them, on Two Bit gulch, yielding some especially fine ore.

TORONTO, ONTARIO

PORCUPINE AND KIRKLAND LAKE.—TWO NEW GOLDFIELDS.—ELECTRIC-STEEL PLANT.

The quarterly report of the McIntyre mines of Porcupine for the last three months of 1916 was most encouraging. The gross production was $356,504, and profits $208,990 against $136,083 for the previous quarter. There was 39,369 tons of ore treated, averaging $10.62 per ton. Operating costs were reduced to $4.51 per ton. Driving has been done for 670 ft. on the 1000-ft. level in McIntyre and McIntyre Extension ground, over 550 ft. being in high-grade ore. Stoping operations in progress show from 8 to 40 ft. wide of ore assaying $15 per ton.—At the Davidson the main vein on the 300-ft. level is reported to have widened to 97 ft., which would make it the widest vein at depth in the Porcupine district, excepting that at the Dome.——The Boston owners of the Premier, better known as the Standard, situated south of Dome lake, have installed a new electric-driven plant, and opened a good orebody on the 100-ft. level. The shaft will be sunk to the 300-ft. level, and cross-cutting done to find this vein. A recent discovery on the 200-ft. level from No. 4 shaft of the Schumacher is developing into an important shoot 9 ft. in width. The West Dome is driving on the 300-ft. level. The vein is 5 ft. wide, and is worth $12 per ton. On the dump, ore is valued at $50,000 and arrangements are under way to have it treated.

At the Lake Shore, Kirkland Lake, development is progressing on the 300-ft. level, where a wide vein carries $18 to $20 gold per ton. The ore opened above this level is estimated to be worth $300,000. An issue of 20,000 treasury shares has been made at 50c. each. Arrangements have been completed for the construction of a mill.——The main vein of La Belle Kirkland has been cut by diamond-drilling at a vertical depth of 650 ft., showing 8 ft. of good milling ore. Two strong parallel veins of less width have been discovered.——The Hurd claims, south of the Tough Oakes, are being worked by La Rose Consolidated of Cobalt, and are developing well.

The new goldfield of West Shining Tree, 20 miles north-east of Kashbaw, a point on the Canadian Northern railway, 80 miles north-west of Sudbury, is attracting some attention. It would have received greater notice had it not been badly handicapped by inadequate transportation. Little development has been done so far, but several syndicates representing New York and Montreal capital are preparing to operate extensively. Of 56 properties, 52 show free gold. The veins vary from a few inches to 15 ft. in width, and from 50 to 2000 ft. in length, generally with good gold-content in the wall-rock.——Another new field that has recently attracted many prospectors is Powell township, situated north-west of Elk lake, and a considerable distance from any other field. The first discovery was made in November, and since then 75 claims have been staked.

Owing to the great demand for high-grade steel for shells, the Imperial Munitions Board is erecting large steel works at Toronto. Sixty acres was obtained on the water-front. The plant may be ready for operation early in July. Equipment comprises ten 6-ton, 3-phase, 25-cycle Heroult-type electric-furnaces requiring 20,000 hp., supplied by the Provincial Hydro-Electric Commission. The plant will not treat crude ore, but will use scrap metal, which is available in large quantities, and from which the best kind of steel is produced. It is expected that when in full operation the output will be 600,000 lb. of steel daily, and from 800 to 1000 men will be employed.

JOHANNESBURG, TRANSVAAL

GOVERNMENT LEASES IN THE FAR EAST RAND.—DOUBTFUL DEVELOPMENT WORK.—NEW METHOD OF SLIME-TREATMENT.

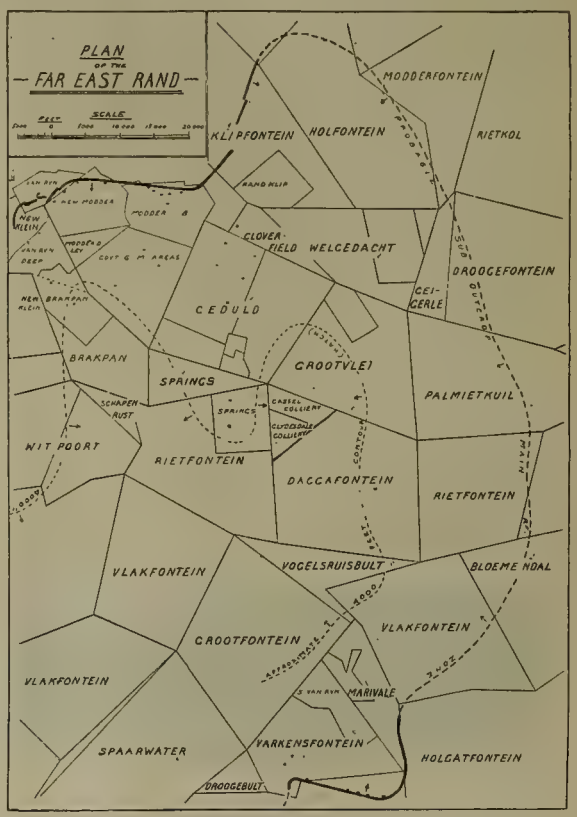
The Government has accepted the tender of the Brakpan Mines, Ltd., for the Brakpan area, and that of the Central Mining & Investment Corporation for the Modderfontein area adjoining the Rand Klipfontein and Cloverfield properties. In the case of Brakpan the area offered for lease amounted to 1811 claims, but the Brakpan company has not only offered the Government a 12½% participation in the working profits in addition to the 10% profit tax, but the property of the existing Brakpan Mines and that of Schapenrust is thrown in on the same terms. This means that, instead of receiving a 12½% participation on the 1811 claims offered for lease, the Government will receive 12½% on the results obtained from 3000 claims. The Government's participation seems to have been arranged so that 12½% of the profits will cover existing conditions, and any increased profits above the average to date, will increase the participation of the Government. For instance, so long as the ratio of net profit to recovery does not exceed 35%, the Government will be entitled to 12½% of the net profits; at 35%, 17.1%; at 40%, 21.3%; at 45%, 24.4%; and at 50%, 27%. If the yield is taken at 27s. ($6.48) per ton, and profit at 9s. ($2.16), this will mean a payment of 12½% of the profits plus 10% profits tax, a total of 22½% or, say, 2s. (24c.) per ton milled, payable to the Government. Another feature of the tender of the Brakpan Mines was the offer to pay 5% of the working profits earned by the Brakpan Mines during the first five years of the lease, in addition to the 10% profit tax. As the present profits of the Brakpan company are £300,000 a year, this means a payment of £15,000 a year plus profit tax during the first five years, during which period no ore can be expected to be extracted from the new area.

With regard to the Modderfontein area, the lease of which has been acquired by the Central Corporation, the terms are undoubtedly favorable to the Government. The amount pay-

able in this case is 10% of the working profits plus the usual 10% profits tax, or 20% in all. Then again the Government will gain considerably by the undertaking of the Central Corporation to form a company with a capital of £752,041, and absorb with the lease-area the properties of Rand Klipfontein and Cloverfield, over which the 20% will become payable to the Government. This means that, in addition to the payment to the Government of 20% of the profits earned on the 651 claims of the lease-area, the same payment will be made on the Rand Klipfontein and Cloverfield properties, amounting to 1799 claims, the 651 claims of the leased area being thus increased to 2450 claims. It is impossible to make any reliable estimate in this case of how much will be payable to the Government, as what little work has been done on the properties cannot be considered as very encouraging. In such a large area, however, as 2450 claims, it can confidently be expected that some profitable ore will be found. Bore-holes on the leased area showed an average value of $5 over a stoping-width, and on the Rand Klipfontein 43,915 ft. of driving averaged $4.60 over 21.7 in., while Cloverfield assayed $16.60 over 11½ in. These are by no means brilliant results, and the Government must be congratulated upon being able to obtain such an excellent offer, for, had the 651 claims been reserved for a State mine, it is extremely doubtful whether the Government could have worked it at a profit.

The proposal to drive two cross-cuts from the bottom of the Angelo Deep shafts on the East Rand Proprietary Mines property to intersect at a distance of 2000 ft., and from the point of intersection to sink a prospecting shaft to the reef, has naturally given rise to much adverse criticism. It is difficult to see the wisdom of such a proposal, as the whole of the work will be done in country-rock, and the probabilities of finding a profitable orebody at the bottom of the shaft so small that such a huge expenditure as £200,000 appears quite unjustifiable. Already one of the directors has resigned in consequence of this proposal, and it will be fortunate if it does not lead to even worse happenings. Naturally, the best method of proving the dip area would be to continue the shafts on the incline of the reef, and should, at any time, a shoot of payable reef be found, arrangements can at once be made to work it to advantage. Then, by following the reef down from the two shafts and driving levels between the two inclined shafts wherever there is any necessity or inducement to do so seems by far the best step to pursue. It is admitted that these inclined shafts will have to be sunk eventually, but the truth is they have been too long neglected, and the foolish expenditure of £200,000 only makes the neglect more prominent. There are great odds against the prospecting shaft finding ore at a depth of 6000 ft. from the surface, but, by sinking on the reef, knowledge is gained all the time regarding the value of the reef, whereas, under the proposed scheme, £200,000 is expected to be spent before any knowledge of the value of the property at this particular point is obtained. It is, of course, possible that profitable areas may be found below the 27th level at the 4000-ft. horizon, where the value is only $2 over a stoping width, but it is highly improbable, and, as a rule, the East Rand Proprietary Mines' property is locally regarded as a white elephant. During December 820 stamps crushed 153,000 tons of ore, which yielded $900,000, of which $180,000 was profit.

A new process of treating slime has been devised by the Mauss Continuous Centrifugal Separator, Limited. Only one machine has started so far, but, from what transpired at the third annual meeting of the shareholders at Johannesburg, there seems every prospect of success being attained in its treatment of slime. A trial was recently made at the Zaaiplaats tin mines, where the pulp fed into the machine was 45 parts of water to 1 of solid by volume, the recovery was 60% of the tin contained in the slime, compared with 25% previously obtained. The machine was first designed to treat slime at the near-by gold mines, but after the test at the Zaaiplaats tin mine it is considered applicable to a variety of metallurgical and industrial purposes. E. J. Way, well known on the Rand for his experimental work, stated that no special arrangements were made at the Zaaiplaats mill for the feeding of slime to the Mauss machine. The current slime was turned direct into the machine and, although the best pulp for the machine was 9 : 1, the slime at Zaaiplaats consists of 45 : 1, nevertheless the results obtained were highly satisfactory. Mr. Way further stated that the product from the Mauss machine had been treated upon Frue vanners and an extraction of 60% metallic tin was obtained. Personally, he had found that Frue vanners were not the best machines to use for this purpose; he much preferred the Deister table, and had no doubt that with adjustments the recovery might be 75%. At the Rooiberg tin mine considerable attention had been paid to the treatment of current slime, and a special



plant for the purpose was erected, but the extraction was only 25%. At the Zaaiplaats, with the Mauss machine and Frue vanners, the concentrate gave from 50 to 55%. The power required to drive the machine is only 2½ hp., while the space it occupies is small. The Mauss machine consists of a drum 4-ft. diam., which, for treating tin slime, is made to revolve on a fixed axle at a speed of 500 r.p.m. Inside this drum are fixed two buckets or receivers revolving in the opposite direction at a speed of 100 r.p.m. The slime is fed into the large drum, which hurls the solid matter into the bucket or receiver revolving in the opposite direction to the drum, the motion of the buckets or receivers being so arranged as to present a clean face to receive the solids, which are delivered at a point arranged for. The water is dealt with by the drum on a similar principle to that of a cream separator, and so far no trouble has been experienced in operating the machine. It is claimed that vanners are too slow in their action to separate the various constituents of slime in a proper manner, but, by using centrifugal motion, perfect separation is obtained.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

ANCHORAGE. John M. Reid and the Mohawk Mining Co., of Anchorage, operating mines in the Willow Creek district, have given the Denver Quartz Mill & Crusher Co. orders for two quartz-mills and other equipment for free-milling ore. The machinery will be shipped from Colorado in time to make connections with the first boat leaving Seattle for Anchorage, usually the first week in April.

FORTYMILE. The earliest placer mining in the Alaska part of the Yukon basin was done on the bars of Fortymile river in 1886, and during the next two years hundreds of miners came to the scene of the discovery. This event opened up inland Alaska and led to the discovery of the famous Klondike placers, on the Canadian side of the boundary, some 10 years later. Over $200,000,000 worth of gold has been taken out of the Klondike and the Alaska Yukon placer districts in the 30 years since Forty-mile was discovered. Of this, $6,500,000 of gold has come from the Fortymile district. This district is described in a report (Bulletin 375) published by the U. S. Geological Survey, entitled 'The Fortymile Quadrangle, Yukon-Tanana Region, Alaska,' by L. M. Prindle.

ARIZONA

AJO. The labor strike at the New Cornelia Copper Co.'s plant, which started on November 19—700 to 800 men going out, was officially declared off on January 19 by the Western Federation of Miners, iron workers, carpenters, and electricians. The men are applying for their former jobs and the company is said to be showing no ill-feeling towards them. Construction of the new reduction and leaching-plant will now be continued. The company is erecting many modern and beautiful dwellings for its employees at Ajo.

LEACHING-PLANT OF NEW CORNELIA COMPANY AT AJO, ARIZONA.

CHLORIDE. A mill of 100-ton capacity is to be erected at the Elkhart mine. F. A. Wright and R. E. Whitcomb are largely interested.

The 1400-ft. level of the Tennessee mine is yielding over $100 ore, according to samples from mine-cars.

The Chamber of Commerce has issued a 30-page booklet describing the Chloride mining district. A frontispiece is a panorama of the principal mines, which are briefly described.

(Telegraphic Correspondence.)—Two cross-cuts 400 ft. apart have penetrated 11 to 14 ft. of ore in the north branch of the vein in the Gold Road mine. A third cross-cut is being driven on the level 200 ft. below the adit where the vein was first opened.

A machinist wiping oil from the pit beneath the large fly-wheel of the hoist at the Nellie mine last week accidentally caught the old overalls he was using for the work in the gears, resulting in smashing the wheel. The mine is shut-down until a new wheel can be cast and shipped to the property.

Within a few days the cross-cut from No. 2 shaft of the United Eastern will have been completed to the vein on the 665-ft. level. The company will install a small auxiliary hoist and resume sinking. The vein should be cut on its dip at about 950 ft. The mill is working satisfactorily.

The Big Jim shaft is now 585 ft. deep, and will be sunk to 620 ft. A station is to be cut at 600 ft., where a cross-cut will be driven to the vein.

The Tom Reed Gold Mines Co. employs a 5-ton auto-truck to transport ore to its mill from the Aztec shaft, distant one mile. A vein of good milling ore 17 ft. wide has been opened at the Gold Ore mine. The company will build a mill soon.

Oatman, January 30.

ARKANSAS

FORT SMITH. To connect this place, at which are zinc smelters, with the zinc districts of northern Arkansas, it is proposed to construct a railway. The Business Men's Club has the matter in hand.

CALIFORNIA

A new geological map of the State of California has just been published by the State Mining Bureau, at the Ferry Building, San Francisco. The geological formations found in this state are shown in 23 colors and symbols. The new map is 50 by 60 in., on a scale of 12 miles to one inch, and represents over two years of painstaking compilation from all available published reports and maps, both Government and private, as well as much previously unpublished data, both official and personal. An entirely new base map of the State was drawn for the purpose, and is strictly up-to-date as regards county boundaries, post-offices, railroads, highways, roads, power transmission-lines, oil pipe-lines, aqueducts, etc. In fact, it contains much more detail of this nature than is ordinarily placed on a geological map. The map is a fine example of draughtsmanship and of the engraver's art. The geology is given in detail, consistent with the scale of the map, and is the resultant work of many years on the part of James Perrin Smith, the well-known geologist. The map is available at $2.50 per copy mounted on cloth with molding at top and bottom for wall-hanging, and $1 per copy unmounted. These prices represent the cost of printing and distribution. This map is to be reviewed in the PRESS of an early issue.

GRASS VALLEY. The Kenosha mine is soon to be re-opened with Lloyd Root in charge. The main shaft will be sunk 800 ft. to 1200 ft. depth. A hoist and pumps have been ordered.

PLACERVILLE. Mining of chrome ore has added to the activity around this place, especially the work of the Manganese Co. of California, which is shipping ore.

COLORADO

BRECKENRIDGE. During the three months ended November 30 last the Tonopah Placers Co., operating three dredges in this district, made a net profit of $64,405.

CRIPPLE CREEK. The report of the Vindicator Consolidated Gold Mining Co. for 1916 has been issued, and the remarks of the general manager, Irving T. Snyder, include the following:

Development totaled 22,029 ft., lessees doing 8294 ft. of this.

The quantity of ore added to reserves was somewhat disappointing, especially on No. 19 level of the Vindicator and No. 20 of the Golden Cycle shafts; but exploration at this depth is relatively little so far. Reserves are estimated at 412,796 tons. Profitable dump ores amount to 2,000,000 tons. Mining cost $2.081 per ton.

The washing and concentrating mill, handling reject material from the Vindicator ore-house, milled 127,947 tons of $1.68 ore at a cost of 17.4c. per ton. The flotation test-plant started work on October 25, treating rejects from the Golden Cycle ore-house, averaging $2 per ton. Ball-mills of 300-ton capacity were installed, but only reduce from 150 to 200 tons. Changes may bring them to the designed output. Results show that the ore can be economically treated by flotation. The recovery is now 93.1%.

The year's output was 119,130 tons of shipping ore, worth $19.27 per ton, of which lessees produced 61,152 tons. The profit was $564,813, of which $270,000 was paid to shareholders. The surplus is $878,580.

LEADVILLE. More rich ore has been found in the Fortune mine in South Evans gulch. Eight feet of sulphide ore at a depth of 1000 ft. contains $95 per ton in lead, copper, silver, and gold. Lessees opened this shoot. As water is expected soon, a motor-driven pump is to be installed.

The U. S. S. R. & E. Co. is now sinking its Jamie Lee shaft with three shifts.

SILVERTON. January ore shipments from this district will exceed those of this month for several years. More work is under way than for some time. Snow has not interfered with operations to any extent so far.

MISSOURI

JOPLIN. The zinc-ore market was $4 per ton stronger last week. Most of the blende sold for above $80 per ton. The average price in January was $74.50. Production of the Missouri-Kansas-Oklahoma region was 8096 tons of blende, 176 tons of calamine, and 934 tons of lead, averaging $79, $49, and $95 per ton, respectively. The total value was $743,240.

From 1830 to 1916, inclusive, the Missouri-Kansas-Oklahoma region has produced zinc and lead worth $328,471,258, of which $34,961,993 was the output of 1916. From 1904 to 1914 the yield ranged from $11,000,000 to $18,000,000.

MONTANA

BUTTE. At the Great Falls electrolytic zinc plant of the Anaconda company 60% of the roasting, leaching, refining, and casting units are in operation.

The Lawrence mine of the Anaconda is to be closed for 60 days to allow of re-timbering the shaft. Cold weather is interfering with other mines being operated.

The Bullwhacker has doubled its daily shipments of 110 tons of ore, which averages 5% copper. Survey of a spur from the Northern Pacific line to this and eastern properties is finished. A leaching-plant is proposed.

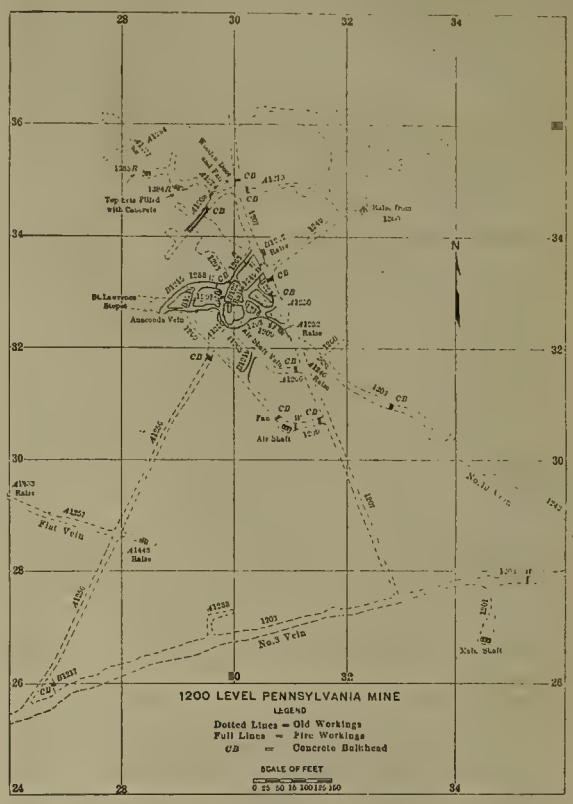
On the 1000-ft. level of the Butte & Zenith stringers of 8% copper ore were cut last week. It is thought these indicate the proximity of the Specie vein. This mine is 6 miles west of Butte.

Pumps have been withdrawn from the Butte & London in the eastern part of Butte and the mine closed, but it is expected that development may be done through workings of the East Colusa mine.

In the U. S. Federal Court for Montana the Elm Orlu Mining Co. is to start suit against the Butte & Superior Mining Co., to restrain the latter from mining on 300 ft. or more of the Rainbow lode in the Black Rock claim of the B. & S. The Elm Orlu also demands an accounting for ore alleged to have been wrongfully extracted. This case is almost a continuation of the one decided in 1916.

During the last quarter of 1916 the North Butte company earned $808,072, of which $322,500 was distributed in dividends. Development, which was satisfactory, totaled 6186 ft. At the Granite Mountain shaft the hoist is operating to a depth of 3600 ft. There was smelted 150,048 tons of ore and precipitate, yielding 6,729,561 lb. of copper, 289,854 oz. of silver, and 501 oz. of gold.

For the February meeting of the A. I. M. E. at New York, C. E. Nigham and R. S. Foster discuss the Pennsylvania mine fire of February 14, 1916, in which 21 men lost their lives on the 1200-ft. level. Immediately after the fire was discovered water was turned into the air-shaft until a suction-fan was installed at the surface of this shaft. When the fan was started there was a reversal of air-current, which was bene-



PLAN SHOWING WORK DONE TO PUT OUT FIRE IN PENNSYLVANIA MINE AT BUTTE.

ficial to those fighting the fire. The methods used were in general those in use at the Mountain View fire of 1913. Drifts and cross-cuts were driven from the nearest accessible workings to the fire, and as much as possible of it was extinguished with hose-lines and by pouring water into the workings above the sill and other inaccessible places by means of diamond-drill holes. The air-currents were controlled with bulkheads, doors, and brattices, so that the men would always be working with the air; that is, so that the smoke and gases would be carried away from them. As far as possible the air-pressure was maintained at a point where it was just sufficient to hold back the gases without supplying fresh air to the fire. All places were securely timbered and air and water-lines were kept in all faces. As many men as possible were employed in all the headings and frequent reliefs were given. The men worked 8-hr. shifts. Where the gases were too strong, helmet men were employed. The helmets used were Draeger, 1909 and 1911 models. In driving the headings great difficulties were encountered because of the gases and smoke, the heavy ground, and the water pouring down from the

diamond-drill holes. Wherever filling was met, spiling or forepoling was necessary, and in many places breast-boards were also required. On April 5, after many cross-cuts and drifts had been driven (see map), a quantity of burning timber fell behind the bulkhead across A 1250 at the junction with 1207. This was quickly extinguished and was the last fire actually seen.

NEVADA

(Special Correspondence.)—The Nevada Consolidated has been able to maintain a 75% capacity during January in spite of excessive cold and shortage of coal. This weather always reduces steam-shovel operations, it being difficult to keep their tracks open and water pipe-lines from freezing; frequently fires are kept burning along the small pipe-lines to the shovels. The worst of the coal shortage appears to be over. The shift trains to the smelter from Ely resumed regular schedule on the 23rd. The power-plant at McGill is using 20% of fuel-oil to assist the coal consumption; the oil costs more than slack coal. At the mines 75% of the ore coming from steam-shovel pits is primary ore. This ore is known to be profitable for several hundred feet below present levels.

The Consolidated Coppermines is treating a small quantity of ore in its 500-ton unit recently completed. It is not expected that much will be done on account of the weather and the coal situation for several months. The Morris shaft, which the company has been sinking slowly for several months, has a large flow of water that hinders operations.

The superintendent of the Ely Consolidated, W. Campbell, is pumping the water out of the Zack shaft. He expects to open the American shaft of the same company at once.

The Camp Bird company, which held a bond and lease on the old Ward mine, 18 miles south of Ely, has stopped work for good. The Denver people who held a lease on part of the ground are continuing work and are advertising for teams to haul ore.

H. C. McCullough, manager of the Argus Mining Co. at Taylor, has several teams hauling ore. He has stuck to this property for nearly 10 years, and deserves success.

The lessees on the Cuba lead mine, of Campbells, at Steptoe post-office, 20 miles north of Ely, have given it up. Several different parties have tried this, but all appear willing to quit.

Lessees on the old Vulcan mine, at Hunter, south-east of Cherry creek, continue to extract ore, but the roads and weather have interfered with shipments. The same conditions apply to several lessees operating at Hamilton.

There is little production of tungsten these days, owing to the market and weather.

During the past few days it has been warm, with thaws every day. If this continues the roads will soon dry and permit resumption of work on some of the outlying properties.

Ely, January 29.

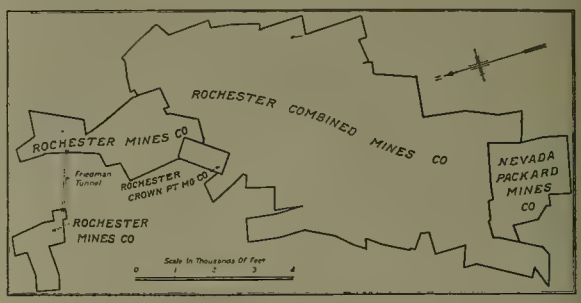
GOLDFIELD. On the 750-ft. level of the Atlanta, 6 ft. of up to $50 ore was opened last week. The ore shows large quantities of copper and silver. This ore will be treated by the Goldfield Consolidated flotation-plant. One hundred tons daily is to be extracted.

At a depth of 880 ft. the Jumbo Extension has opened a large shoot of gold-silver-copper ore, some of which assays $40 per ton. Core-drilling continues at 1017 ft. depth.

Profit of the Goldfield Consolidated during December was $16,441 from 26,000 tons of ore. Costs totaled $4.59 per ton.

RAND. The Nevada Rand Mines Co. has recently been financed by Eastern capitalists. The work of sinking the shaft from the 250 to 450-ft. level commenced in December with one shift. The force will be doubled on February 1. This property has produced over $30,000 in silver and gold.——Sinking the shaft below the 330-ft. level is in progress on the property of the Queen Regent property adjoining the Rand mine.——A new development of 4 ft. of ore carrying over $40 gold per ton has recently been made in the Gold Pen mine, which is also on the Rand fissure. The vein on the 260-ft. or bottom level of this mine is 26 ft. wide, 5 ft. of which assays $19 per ton.——Three producing mines on the Rand fissure have produced $150,000 in silver and gold.

ROCHESTER. In last week's issue mention was made of the consolidation of properties at Rochester, and the accompanying map shows the boundaries of the new company, and the other two principal operators.



PART OF ROCHESTER DISTRICT, NEVADA, SHOWING THE RECENT CONSOLIDATION OF PROPERTIES.

The Rochester United, on Sunflower hill, has received settlement for 21 tons of ore assaying 2.23 oz. of gold and 4 oz. of silver per ton. Development is reported to be encouraging.

TONOPAH. During the quarter ended Nov. 30, the Tonopah Mining Co. had a net income of $308,460, compared with $122,712 in the previous period, although in the November term the profit from ore was $179,117. Assets total $1,593,812, including $117,970 cash, $1,019,831 bonds, and $431,011 silver stored. A dividend on January 20 absorbed $150,000.

The Belmont company expects to have its new mill at Surf Inlet, B. C., completed by July. Flotation is to be used.

NEW MEXICO

(Special Correspondence.)—During 1916 the Mogollon Mines Co., operating the Last Chance and Top mines, marketed 305,867 oz. of bullion, containing 5793 oz. of gold and 277,330 oz. of silver; also 93.8 tons of concentrate, containing 1378 oz. of gold and 94,020 oz. of silver. Development amounted to over 2200 ft., including 650 ft. of the new three-compartment shaft, which is now completed to 900 ft. This property has produced steadily for 15 years, and is one of the largest gold-silver mines in the south-west.

Development work on the Pacific mine has been confined to the 4th and 5th levels, as the present hoisting-plant is being worked to capacity. The new aerial tram is moving ore to the Socorro mill, one mile away. The cables run over regular standards to the edge of Silver creek, where one span of 2630 ft. connects it with the mill terminal. The buckets passing over the Maud S. mill travel 600 ft. above the creek. Each bucket carries 625 lb. of ore, 13 buckets are used, and 75 to 80 tons of ore can be moved to the mill in one shift.

The Oaks Company reports the following properties under operation during the week: Oaks drainage-tunnel, Harry, Johnson 19, McKinley tunnel, Clifton, and Eberle. The last two properties are shipping all ores taken out in development to the Socorro mill.

The cyanide shortage, which has been threatening to curtail mill operations, has been relieved, a fair supply having been secured.

Mogollon, January 23.

UTAH

Shortage of railroad cars is curtailing movement of ore in this State, especially at Alta and Tintic.

AMERICAN FORK. The coming season is to be the busiest on

record in this district. Electric power now being available makes power problems easier.

Park City. After being enlarged the Broadwater mill is to resume shortly. The Big Four plant, closed on account of the weather, is also to re-start. When the new electrolytic plant of the Judge company starts it will have over 3000 tons of high-grade zinc concentrate to treat.

Tintic. The 250,000-ton tailing-dump of the Mammoth, containing gold, silver, lead, and copper worth $7 per ton, is to be sent to Utah smelters. Either the D. & R. G. or the Salt Lake Route will construct a spur to the dump.

Wendover. As the Ferber district is showing considerable activity it is planned to construct a branch from the new Deep Creek line in the spring. The mines of Ferber contain copper and lead-silver ores.

WASHINGTON

Seattle. The Bureau of Industrial Research of the University of Washington has issued a preliminary report on its investigation of the iron-ore resources of the Pacific North-west. Active work on this investigation was begun in June 1916, by the appointment of A. S. R. Wilson, as geologist, and W. H. Whittier, as research fellow. Both of these men graduated in 1916 from the College of Mines of the University. The geological work done during the summer months last year consisted of an examination of iron-ore deposits at the following places: The magnetic black sand at the mouth of Sombria river on the west coast of Vancouver island; magnetite on Texada island; magnetite on the Kasaan peninsula, Prince of Wales island, Alaska; and magnetite on Louise island, Queen Charlotte group. The geologic investigation has resulted in the determination that the magnetic sands as a source of iron ore in commercial quantity are not important enough to warrant further investigation, particularly in the light of the known occurrences of magnetic iron ore. It was also determined that magnetites occur over a wide range of territory tributary to the Pacific north-west and that further exploration is necessary before complete information dealing with exact resources will be available. In addition to the geological study of these deposits, samples amounting to over 2000 lb. were collected for further work at the laboratories of the university. These samples are now being analyzed for iron-content and impurities, and are being used in making mill-tests to determine the best methods of concentration and elimination of undesirable elements in the iron ore. This work is being completed as rapidly as possible so that information dealing with the character of the raw materials may be available soon. Economic questions dealing with the possible establishment and operation of an iron and steel plant in the North-west are being studied by Mr. Whittier. This investigation deals with the consumption of iron and steel products; the domestic and export market, especially the territory along the Pacific Coast; the influence of water transportation for the eastern region of this country and from China; the cost of raw material; the cost of production of iron and steel, and the market prices. The investigation will not be completed for some time.

The Bureau of Industrial Research is a result of a meeting which Henry Suzzalo, president of the University, had with a group of Seattle and Tacoma business men in which they offered to finance such an investigation.

KOREA

During December the Seoul company recovered bullion worth $133,705. The net amount received during 1916 for copper sold at prices exceeding the basis used in monthly reports was $150,000. Preliminary prospecting at Nau Churi shows interesting developments, and developments of the Tong Ahm property continues satisfactory.

The November clean-up of the Oriental Consolidated was $135,865; December, $164,239; 50c. dividend January 25.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

Courtenay De Kalb is at Globe, Arizona.

Corey C. Brayton is visiting mines in Utah and Montana.

Waldemar Lindgren is to be in South America for four months.

Victor C. Alderson now has his office at 185 Devonshire street, Boston.

E. W. Carson is superintendent of the Oceanic quicksilver mine, California.

F. A. Malins is mill superintendent for the Dos Estrellas company at El Oro, Mexico.

P. B. McDonald has been appointed instructor in technical writing at the Toledo University, Toledo, Ohio.

G. B. Butterworth has been appointed manager of the South American Copper Syndicate's mines at Aroa, Venezuela.

D. C. Bard of Butte has joined the geological staff of the C. M. & St. P. railroad, and will have headquarters at Seattle.

Henry P. Smith and Joseph Macdonald, Jr., of the Guanajuato Reduction & Mines Co., Mexico, are inspecting flotation-plants in Nevada.

Samuel H. Dolbear, consulting mining engineer, announces the removal of his offices to Merchants National Bank building, San Francisco.

Brent Neville Rickard, metallurgist, has been transferred from the Tacoma to the Murray plant of the American Smelting & Refining Company.

T. A. Rickard delivered a course of five lectures on 'Technical Writing' during the past week to the engineering students in the University of California.

T. N. Stanton, late superintendent of mines for the Cananea Consolidated Copper Co., Cananea, Mexico, has returned to South America, and is superintendent of mines for the Cia. Estanifera de Llallagua, Llallagua, Bolivia.

Obad A. Palmer, well known in Utah, died at Salt Lake City on January 13, at the age of 78. His work in the Park City and Tintic districts was of great value in subsequent development.

Belgian Relief Commission

The directors of the American Institute, on January 26, 1917, passed the following resolution unanimously:

In the name of all the members of the American Institute of Mining Engineers, this Board extends to Mr. Herbert C. Hoover, an honored Vice-President of the Institute, on the occasion of his present temporary return to his native land, the cordial welcome of his colleagues, and their congratulations upon the noble work splendidly done by the Commission for Relief in Belgium of which he is the head.

It is understood that a leading purpose of Mr. Hoover's visit to America at this time, is the collection of additional funds, to be administered by his Commission in the care of the destitute children of Belgium. To this enterprise endorsed by both belligerent parties, as well as inspired by the purest and tenderest sentiments of humanity, contributions are solicited from engineers, especially through an organization known as the 'Belgian Kiddies Limited,' which this Board, heartily approving its object and method, recommends to the consideration of the members of the Institute.

On motion duly seconded it was unanimously voted

That this minute be spread upon the record of the Board, and published in the Bulletin, and that a copy thereof be transmitted to Mr. Hoover, and to the San Francisco Section of the Institute.

THE METAL MARKET

METAL PRICES

San Francisco, February 6.

Antimony, cents per pound	24
Electrolytic copper, cents per pound	35
Pig lead, cents per pound	8.25—9.25
Platinum, soft and hard metal, per ounce	$85—91
Quicksilver, per flask of 75 lb	$90
Spelter, cents per pound	12
Tin, cents per pound	48
Zinc-dust, cents per pound	18

ORE PRICES

San Francisco, February 6.

Antimony, 50% metal, per unit	$1.00
Chrome, 40% and over, f.o.b. cars California, per ton	18.00—20.00
Magnesite, crude, per ton	8.00—10.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO_3 per unit	17.00—20.00

Tungsten appears in good demand with a slight advance in price from $17.50 to $20.

New York, January 31.

Antimony: High-grade ore is quoted at $1.85 per unit.

Molybdenite: Further business for delivery within three months has been done at $1.80 per lb. MoS_2 for high-grade concentrate.

Tungsten: About 300 tons has been placed under contract at prices close to $17 per unit. It is reported that cold weather is interfering with production in the West, giving the market a stronger aspect.

EASTERN METAL MARKET

(By wire from New York.)

February 6.—There is no market for copper; prices are purely nominal. Lead is scarce with prices nominal. Spelter is quiet, and sellers are reserved.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Jan.	31	Dec. 26	31.55
Feb.	1	Jan. 2	29.90
"	2	" 9	28.20
"	3	" 16	28.33
"	4 Sunday	" 23	29.34
"	5	" 30	31.91
"	6	Feb. 6	33.00

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	....	Aug.	17.27	27.03	....
Mch.	14.80	26.65	....	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

The American Brass Co. in 1916 made a net profit of $10,991,669, as compared with $6,128,453 in 1915 and $1,450,347 in 1914. This concern uses more than 100,000,000 lb. of copper annually.

The Utah Copper Co.'s output in December was 13,976,533 lb. of copper as against 16,421,192 lb. in November and 20,325,520 lb. in October.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Jan.	31	Dec. 26	76.05
Feb.	1	Jan. 2	75.37
"	2	" 9	75.28
"	3	" 16	74.66
"	4 Sunday	" 23	75.87
"	5	" 30	75.87
"	6	Feb. 6	76.79

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	48.85	56.76	75.41	July	47.52	63.06	....
Feb.	48.45	56.74	....	Aug.	47.11	66.07	....
Mch.	50.61	57.89	....	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

The American Line has refused to take silver for transport to Europe because of the action of the German government in declaring gold and silver to be contraband of war. Although silver quotations are determined in London, the price-fixing is dependent on the figure at which the metal can be secured in New York, and eventually the buyers must pay the heavier insurance rates, as American bullion dealers will probably hold the silver for higher prices.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Jan.	31	Dec. 26	10.00
Feb.	1	Jan. 2	9.75
"	2	" 9	9.66
"	3	" 16	9.37
"	4 Sunday	" 23	10.00
"	5	" 30	10.41
"	6	Feb. 6	10.06

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	....	Aug.	14.17	9.03	....
Mch.	8.40	18.40	....	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Jan.	31	Dec. 26	7.50
Feb.	1	Jan. 2	7.49
"	2	" 9	7.50
"	3	" 16	7.50
"	4 Sunday	" 23	7.72
"	5	" 30	8.02
"	6	Feb. 6	8.41

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	....	Aug.	4.67	6.28	....
Mch.	4.04	7.26	....	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

The Bunker Hill & Sullivan Mining Co. paid dividend No. 245 on February 3, of $81,750, and on the same day an extra dividend of $81,750. Total paid to date $18,816,750.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Date.		Jan. 23	80.00
Jan.	9 80.00	" 30	85.00
"	16 80.00	Feb. 6	90.00

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	....	Aug.	93.75	74.50	....
Mch.	78.00	219.00	....	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

Quicksilver is showing increased activity having advanced $10 within the past two weeks to the present price of $90 per flask.

TIN

Prices in New York, in cents per pound.

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	....	Aug.	34.37	38.88	....
Mch.	48.76	50.50	....	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

ALUMINUM

Domestic consumption of aluminum in 1916 was over 121,000,000 lb., an increase of more than 21% over the consumption of 1915.

ANTIMONY

For Chinese and Japanese brands, 23 to 25c., duty paid, is quoted, prices having gone up sharply as a result of delayed deliveries from the West. It is admitted that a large quantity is in transit from Vancouver, but railroad conditions make the time of its arrival most uncertain. Considerable metal is in storage in this city, but the holders are unwilling to release it, for the reason that they must keep themselves in a position to meet their commitments of the next few weeks.

PLATINUM

Price of platinum, New York is $100 per ounce for soft metal and $106 for hard.

Eastern Metal Market

New York, January 31.

Copper is quiet, but nominal prices are fast getting back to high levels that prevailed in early December.

Zinc made a good start upward in the past week, but consumers did not support the rise, and the market is easier again.

Lead is the strongest of any of the metals—also the most difficult to find for prompt delivery. The A. S. & R. Co. has advanced its New York quotation to 8c., but the independents are asking up to 8.25c., and needy consumers would undoubtedly pay 9 cents.

Tin is higher because of a stronger London market.

A scarcity of supplies is sending antimony to high levels again, the prevailing quotation being 23 to 25 cents.

Aluminum also is stronger at 58 to 60 cents.

All the metals, and for that matter products of every description, are suffering from bad railroad conditions prevailing throughout the country, particularly in the West. At Eastern terminals, the freight congestion grows, while in the other parts, car shortages and bad weather conditions add to the trials of shippers. Traffic troubles have made the past week one of the quietest for some time in steel. Despite adverse conditions, the U. S. Steel Corporation in the last quarter of 1916 earned $106,000,000, but the larger earnings are yet to come, as deliveries at the 2c. level have not yet been cleaned up. Foreign buyers, in their anxiety to obtain steel, are becoming less strict with regard to their specifications. All exports are restricted by the great difficulty of finding ocean freight-space. Prices remain firm in every direction in the iron and steel field. The metal-working machinery trade is quieter, and deliveries are becoming easier, especially where machines are not strictly high-grade.

COPPER

The copper market is practically back where it was prior to the break that followed the peace talk. Near-by and spot metal is practically unobtainable, despite the quantities which were pressed for sale, during the decline, by dealers, consumers and even some of the producers, all of which is evidence that faith in the situation is quite generally restored. Present quotations are nominal, inasmuch as there are few transactions to test the market. Strictly spot is quoted by some of the dealers as high as 35 to 36c. per lb., but more conservative factors put spot at 33 to 33.50c., February at 31.50 to 32.50c., March at 31.50 to 32c., and second quarter at 30 to 31c. Talk of a big order to be placed by the Allies for second-half delivery has subsided to a great extent. Just why copper is so scarce is explained only by conjecture. It has been maintained that the producers did not want to sell because of their expectancy of a big foreign order, also that they are short of metal and need all they have for the fulfilment of commitments. It is certain they are behind on deliveries. Severe weather in the West has impeded production, the railroad congestion has delayed deliveries of raw materials and finished products, while labor troubles at Eastern refineries have cut down production. It seems logical to suppose that the producers have none too much metal to satisfy demands they must meet. The big purchase by Great Britain, for instance—calling for 200,000 tons to be delivered in the first six months of 1917, at the rate of 75,000,000 lb. per month—has entered upon its period of delivery, but export statistics for January do not show that foreign shipments have been increased. Exports for the month, lacking one day, total 23,551 tons, which is under normal. All this argues for a strong market. Bearing out some of the foregoing, it is estimated that the January production was but 183,000,000 lb., against 210,000,000 lb. in December. For the first time in months the London market has shown an advance in the past week, the last price cabled for spot electrolytic being £143. The trade, however, attaches little importance to the advance in view of the fact that prices in Great Britain are officially controlled.

ZINC

In the past few days it has appeared that zinc was in for a steady and important move upward, but on Monday (January 29), when the New York quotation for prime Western ranged from 11 to 11.12½c. there came a slump which can only be credited to the rush to sell. Prices broke at least ¼c. that day, and business became quiet. It was demonstrated that considerable spot and near-by zinc is in the East. Yesterday the New York quotation was about 10.75c. for spot and February, with March about 10.50c., and second quarter about 9.75c., the St. Louis prices ranging about ¼c. lower. The conclusion to be drawn from the drop in prices is that the advance was abortive because of the lack of sufficient needy consumers to support it. An interesting phase of the situation according to a representative of one of the producers, is that Joplin ore—now quoted around $90 per ton—is not fixing the price of zinc, but zinc is fixing the price of the ore. Brass-mill special commands a premium of 1 to 1⅛c. over prime Western. Exports in January, lacking one day, total 7555 tons. The London quotation for spot yesterday, the 30th, was £47, unchanged as compared with a week previous. Sheet zinc remains at 21c. per lb., f.o.b. mill, carload lots, 8% off for cash.

LEAD

In this metal most of the interest of the week has been centred. Freight conditions are holding up thousands of tons in transit from the West, and the result is a shortage which makes spot and near-by practically unobtainable, except for small lots, and even these are not easy to find. A few consumers have been obliged to close their works, and more are likely to shut down unless the situation is relieved—and no relief appears to be in sight. A dealer relates that a shipment which he hopes will reach him some time has been on the way since early November. Neither he nor the railroads know where it is. Incidentally the trade is wondering what will happen to prices when shipments do break through. On January 29 the A. S. & R. Co. announced its long expected advance, making its New York quotation 8c., but the announcement had little effect on the outside market, inasmuch as the new price is only used as a basis for compiling monthly averages. Those who have lead can get almost anything they want for it—some buyers would be glad to pay 9c. Sales were made within the past day or two at 8.10c., f.o.b. St. Louis, February shipment, and at 8.25c., New York. The London quotation is unchanged at £30 10s. for spot. Exports of the month, lacking one day, total 1290 tons.

TIN

Continued advances at London have carried the spot Straits price to £193 2s. 6d. (equivalent to 41.05c.), which was the quotation yesterday (January 30), compared with £189 on the 22nd. Some important London traders have been buying heavily of late. Deliveries into consumption in January established a new record, amounting to 7177 tons, the previous high figure having been 6398 tons last June. Of the January deliveries, 1977 tons came via Pacific ports. Business in New York has been light since the last report, but the strong London market caused prices to advance, today's quotation being 45.75c. In stock and landing at the end of January was 2622 tons, while there was afloat 3033 tons.

Silver in 1916

*Briefly the following factors affected the market during the past year:

Month	Average price per oz. New York, cents	London, pence	Factor
January	56.775	26.960	General coinage demand for allied and neutral nations
February	56.755	26.975	
March	57.935	27.597	Indian Mint starts to buy
April	64.415	30.661	Heavy shipments from China
May	74.269	35.476	Great reduction in Indian Treasury silver reserves
June	65.024	31.060	Less competition from Allied Governments
July	62.940	30.000	
August	66.083	31.497	United States loan to China, part remitted in silver
September	68.515	32.584	Demand for U. S. Mint
October	67.855	32.360	Some speculative activity for the rise
November	71.604	34.187	Cessation of China sales
December	75.765	36.410	Indian Mint a keen buyer

These prices were for cash delivery, there being no quotations for two months' delivery.

The year opened with fair prospects for silver. Coinage for Allied and neutral European nations was in operation, and a steady continuous pressure was being exerted upon the world's supplies in order to fill currency demands in England and abroad, which became keener as the year wore on. During the first 2½ months the price kept within §d. (1¼c.) of 26⅛d. (53⅜c.) The reluctance of prices to rise, notwithstanding the strength of the market, was attributable to sales of silver on account of China, where the visible accumulations of metal were large. The Indian Bazaars betrayed only an intermittent interest, not of an active character. Meanwhile a persistent decrease in the holding of silver rupees by the Indian Treasuries indicated that purchases would have to be made ere long for the Indian Mints. The War had imposed an unusual strain upon the stock of rupees. In three great theatres of the War —Mesopotamia, East Africa, and Egypt—these coins were in exceptional demand. In the last-named country the rupee was made legally current as a temporary expedient, until such time as sufficient piastres could be minted and put into circulation to meet the need of the troops. The large quantity of rupees that have obtained a fresh domicile, especially those in Mesopotamia, will not be quickly repatriated. Circulating among the Arabs and other denizens of countries bordering upon the Persian gulf, they have filtered into the interior, where silver currency, hitherto somewhat of a luxury, is welcome. An urgent demand for new currency in Australia, owing to the activity of war industries, led to an arrangement for silver yielded by Australian mines to be minted in the Commonwealth, so as to relieve the Royal Mint at London, fully occupied with British coinage. In the third week of March, a shipment of £350,000 was announced from China to India, and a sharp change came over the market. The stock of rupees in the Indian Treasury was 2806 lacs (1 lac = $32,000) on December 31, 1915. By March 22, 1916, the total had fallen without a break to 2215 lacs; hence there was little doubt that the shipment was made on account of the Indian government. The price at once sought a new level, reaching 28⅛d. on March 24, and hovered in that neighborhood until the beginning of April, when a fresh upward movement began. Notwithstanding substantial purchases of silver in China, and also in London, the drain of rupees from the Indian treasuries still continued until on December 22 the total was only 1623 lacs, a decrease of 1183 ($37,856,000) in a year. The note circulation meanwhile increased from 6297 to 7963 lacs. During April, currency demand became increasingly active for the Continent as well as for the Indian and British mints. The last mentioned continued to find difficulty in coping with local needs. The healthy condition of the market encouraged speculative purchases on the part of the Indian Bazaars and elsewhere. The impetus generated by enquiries, so varied and constant, carried the price to 30d. within a fortnight, and to 31 3/16d. within three weeks, and from this point until May the market developed remarkable strength. The highest quotation in 1916—37⅛d.—and the highest since 1893, was on May 3. It may be here observed that the great reduction in supplies from Mexico, where unrest has seriously hampered mining operations, especially in the northern districts, accentuated the difficulty of meeting the unusually urgent requirements that had arisen. Further, the undefined political situation in China prevented the trade of that country from acting as a counterpoise to silver in accordance with custom. High silver prices acting upon the China exchanges formerly had the effect of encouraging automatically foreign imports to a degree somewhat commensurate with the rise in rates, but internal conditions in China and the difficulty of shipping were not favorable to foreign imports. Therefore, the release of silver from China represented rather a transfer of capital than a transfer of trade. Hence the link between silver and the China exchanges failed to check the headlong course of the market. Some new sources of supply were tapped. Certain current coins, such as Mexican, Philippine, Maria Theresa dollars, etc., became worth more dead than alive. After a healthy reaction the price again mounted as high as 37d. on May 12. On the 15th, the total of silver—coined and uncoined —in the Indian reserves fell to 1771 lacs, the lowest figure recorded since January 24, 1914. This had much to do with the strong tendency of the silver market, for the currency figures are always closely watched by the Indian Bazaars. Not without reason, for they afford a reliable barometer—and a fall to 1800 lacs has been considered by authorities as danger-point. The reduction below the total hitherto considered advisable naturally encouraged speculative buyers, and the quotation kept at 36d. or over until May 20. An arrangement having been made to avoid unnecessary competition between mintage orders, the Indian Bazaars—at the time large speculative holders—took alarm, sold heavily, and by so doing, depressed the price instantly to 34d. on May 22. The decline continued, despite temporary rallies caused by spasmodic spells of speculation, until 28§d. was quoted on July 10. Throughout this period the Indian government, assisted by falling China exchanges, was able to replenish its reserves with such success that the Indian Bazaars, becoming obsessed with unfavorable views, not infrequently made bear sales in the London market. For the next 2½ months the inclination of prices was steadily upward. A loan by the United States to China reduced supplies from America to the open market, inasmuch as about 1,000,000 oz. was remitted in silver. On the other hand, China sold frequently either to the Indian Mint, the Bazaars, or London. Throughout October the price remained steady. Meanwhile the United States Mint absorbed some of the local supplies. The stock in Shanghai continued to shrink, and the China exchanges began to approximate the par of silver, suggesting that China had released about as much silver as could be spared, in view of the growing activity of its exports. Early in November the tables were turned, China ceased selling and commenced buying. The new factor

*Abstract from 'Annual Bullion Letter' of Samuel Montagu & Co., London.

was felt at once. The price rose rapidly, and after a slight reaction the advance was resumed until 36d. was recorded on December 2. The price remained about this figure for a few days and then again took an upward course, which carried it to 37d. on the 15th. This figure was attained the day after the Indian government announced that its allotments of Bills and T.T. would be confined to the amounts offered for tender. The main factor in these rising prices was the continuous and heavy withdrawal of rupees from the Indian Treasury. In the latter half of December a considerable quantity of silver—reported as over £1,000,000 in value—was acquired for the Indian Mint at Bombay and Calcutta. The pressure being somewhat relaxed, prices eased off toward the close of the year.

Appended will be found the apparent stocks of bar silver at the close of 1916 as closely as can be ascertained, together with corresponding figures for the three preceding years, in ounces:

	1916	1915	1914	1913
Shanghai	not reported	720,000	500,000	2,660,000
Bombay	2,420,000	6,900,000	5,000,000	1,320,000
At sea	*1,400,000	3,125,000	1,500,000	2,000,000
London	6,350,000	6,800,000	11,000,000	15,800,000
Total	10,170,000	17,545,000	18,000,000	21,780,000

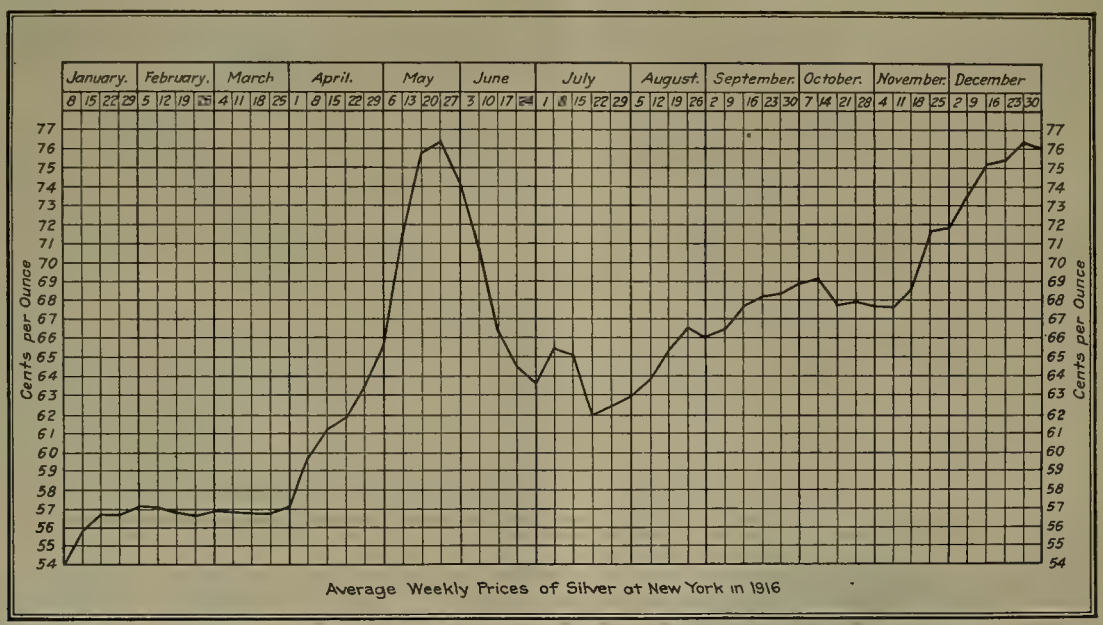
*Exclusive of silver consigned to the Indian government.

The totals of sycee (60-oz. shoe-shaped bars) at Shanghai for the four periods were 1916, 23,900,000 oz.; 1915, 62,100,000 oz.; 1914, 68,000,000 oz.; and 1913, 50,300,000 ounces.

Two circumstances are of interest in connection with the shipment of silver from China. First, that the demand for remittances to London was large and continuous, and evidently independent of the movement of trade. The likeliest solution is that foreigners in China have been transmitting unusually large amounts of capital from China to the United States and Europe. Second, China could not indefinitely dispense with the currency represented by these shipments of sycee and dollars that have taken place. The reflex influence of the operations referred to, must ultimately be felt by the future trade in China, inasmuch as the replacement of the exported currency, which may amount to one-quarter of the world's production for one year or even more, will influence considerably the price of silver and China exchange rates in sympathy. The shorter the period during which such replacement takes place, the more powerful the leverage will be upon the price of silver.

It is not surprising that the Indian Mint has figured as an extremely important buyer, for there has been not only external demand for silver rupees incidental to the War, but Indian crops have commanded unusually high prices. The Indian peasants, therefore, required correspondingly large payments in a unit commensurate to their daily needs.

Concerning the future of silver, present world conditions being unprecedented, and the course of events touching finance so uncertain, any forecast of future movements of the price would be guesswork. However, two factors can reasonably be anticipated to be an influence during the War, namely: a more or less persistent demand for silver currency as a consequence of the locking-up of gold and other causes, and a degree of stringency of supplies, owing to the great drain made on them during the past year.


January. February. March April. May June July August. September. October. November. December
Cents per Ounce
Cents per Ounce
Average Weekly Prices of Silver at New York in 1916

During 1916 the New York & Honduras Rosario Mining Co., operating in Honduras, Central America, yielded an average of 150,600 oz. of silver and 1280 oz. of gold per month, from 10,565 tons of ore. The value averaged $125,000. The December output was 11,600 tons for 182,000 oz. of silver, and 1550 oz. of gold, valued at $165,000. In 1915 the average monthly yields were 9815 tons, 145,659 oz. of silver, and 1267 oz. of gold, valued at $97,125. Silver in 1915 realized 50.1c. per oz.; in 1916, 66.6 cents.

The Calumet & Hecla company reports as follows for December and 1916, in pounds of copper:

Mine	December	1916	1915	1914
Ahmeek	2,321,536	24,142,158	21,800,492	13,634,605
Allouez	770,223	10,219,290	10,043,459	6,056,548
Calumet & Hecla	6,424,053	76,762,240	72,613,320	53,691,562
Centennial	193,050	2,367,400	2,347,500	2,287,130
Isle Royale	1,113,814	12,412,111	9,342,106	6,601,235
La Salle	169,211	1,380,352	782,493	540,731
Osceola	1,561,836	19,586,501	19,731,472	14,970,737
Superior	254,477	3,034,656	3,866,484	3,217,635
Tamarack	582,267	6,618,507	3,888,150	1,074,808
White Pine	238,307	4,207,449	2,824,145	.....
Total	13,628,774	160,730,664	147,239,621	102,074,992

Industrial Notes

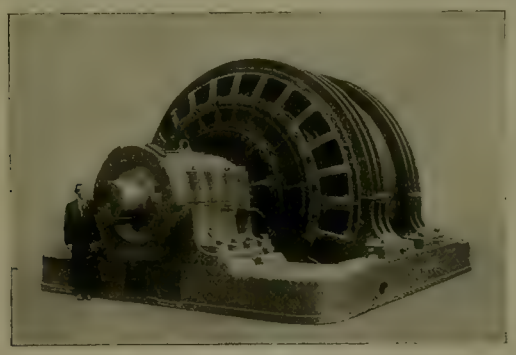
Information supplied by the manufacturers.

A New Gable-Bottom Ore-Car

The Orenstein-Arthur Koppel Co. of Koppel, Pa., claims that its new car possesses every improvement known in gable-bottom iron-ore cars. The side-door locking-gear is of special interest as each door is held closed by a longitudinal shaft running along the bottom edge of the car underneath the door, the shaft being provided with manganese cast-steel hooks which engage the bottom of the door. This shaft has a hand lever at one end, and the lever is kept in position by means of a spring-catch. Previous designs for a door locking-gear provided for a longitudinal bar fastened to the door, the bar fitting into catches at each end of the car, but on account of the load pressure against the doors it was necessary to hammer the catches loose; the catches also became filled up with dirt and ice so much that it was difficult to unlock the door. The construction of this car does away with the defects mentioned thus effecting a considerable saving in time and repair expense. Manganese-steel wheels with caged roller bearings are used. Cars of this type are being used extensively for locomotive haulage in the Michigan and Minnesota iron-ore ranges on account of their rugged construction and ease of operation. Some thirty odd of these cars have lately been shipped to the Pickands Mather Co.'s properties in Minnesota.

The Largest Electric Motor

The accompanying illustration shows the largest electric motor ever constructed, namely, of 15,000 hp. It was made by the Westinghouse Electric & Mfg. Co. of East Pittsburg, and



THE LARGEST ELECTRIC MOTOR.

is described as a reversing motor, designed for driving 35-in. reversing blooming mills in steel plants. The man standing by the machine is 6 ft. high, so further details of size would be superfluous.

Commercial Paragraphs

In catalogue No. 710, of 106 pages, the HARRISON SAFETY BOILER WORKS of Philadelphia describes and illustrates its open feed-water heaters, heaters and receivers, valve-stack heaters, and water-softener heaters.

The Union Zinc Co. at Knoxville, is enlarging its mill, and has just given the DENVER QUARTZ MILL & CRUSHER Co. a hurry-up order for a quartz mill. A. A. Blow is president of the company, which uses oil flotation in treatment.

In its new 55-page catalogue SAUERMAN BROS. of Chicago detail and show the use of their power-scraper. Stock sizes range from ¼ to 2-cu. yd. capacity. Any power may be used. Sketches are given showing arrangements of scrapers in the field.

In Bulletin No. 250, the SPRAY ENGINEERING Co. of Boston, Mass., describes and illustrates in an informing manner its 'spraco' equipment for washing and cooling the ventilating air for steam turbine-driven generators. The spray-nozzles are shown in detail.

In the suits of the DEISTER CONCENTRATOR Co. *v.* the DEISTER MACHINE Co. in Indiana and Chicago the Machine company won. In the first case it was a question of the use of the name by the Machine company; in the second it was in regard to infringement of the Concentrator company's patents.

The JASPER QUARRY Co. of Sioux City, Iowa, is quarrying a bed of extremely hard dense quartzite that is used in grinding-mills requiring a refractory lining. The company says it has already been subjected to severe tests and that it has come up to every requirement. It has been placed on the market under the trade name of adamant-silica.

On January 3, 1917, at the Pittsburgh Athletic Association, occurred the annual convention and banquet of the sales representatives of the VANADIUM-ALLOYS STEEL Co., Pittsburg, Pa., which manufactures high-speed, carbon, and alloy tool-steel. Some interesting topics were thoroughly discussed, the most prominent being a paper on crucible tool-steel read by Roy C. McKenna, president of the company. This company has for free distribution a folder descriptive of 'vasco-marvel,' a semi high-speed steel. This folder contains much information of interest, together with the high-speed steel standard classification of extras adopted July 22, 1915. The company owns valuable tungsten properties near Boulder, Colorado.

Bulletin No. 70-A, second edition, of the SULLIVAN MACHINERY Co., describes the Sullivan rotator hammer-drills, classes DP-33 and DR-33. Standard rotators are made in five different styles, as illustrated and described in this bulletin. These include a drill with hollow piston, a drill with air-tube, one with tube for use with steam, and one with water-tube for cleaning the hole for use in driving. Two styles of mountings are described; the shell and cradle mounting with feed-screw, and the pneumatic-feed mounting. The DR-33 auger-type rotators for soft ground, are also fully described, and the bulletin contains a number of new illustrations showing the application of these practically 'all-around' hammer-drills to different classes of rock-drilling work.

The CHEMICAL ENGINEERING catalogue recently issued is another instance of the American tendency to do something in a better way than it has been done before, and to do it more cheaply, by doing it more scientifically. The catalogue is a standardized collection of the advertising matter of the various manufacturers of chemical engineering apparatus and supplies, and will eventually contain in a single volume practically all of the available information on raw materials, equipment, and supplies that previously has demanded the maintenance of an extensive file of manufacturers' catalogues and an elaborate filing system. This catalogue is a convenience and an economy to both producer and consumer, and since it is thoroughly indexed and cross-indexed, it serves the additional purpose of the ordinary trade directory.

HEATON'S ANNUAL, 1917. Commercial handbook of Canada. P. 518. Index. Heaton's Agency, 32 Church street, Toronto, Canada. Price, $1.25.

With its usual promptness, this annual reference book on all matters pertaining to the Dominion of Canada, is now to hand. Several improvements and refinements are noticeable in this, the 13th number. Statistical data are official. Readers of the PRESS will naturally turn to the mining section and will find 16 pages devoted to the minerals of Canada. Generally speaking, Heaton's will be found worth a place on any book-shelf.

Mining and Scientific Press

Edited by T. A. RICKARD

Volume 114
Number 7

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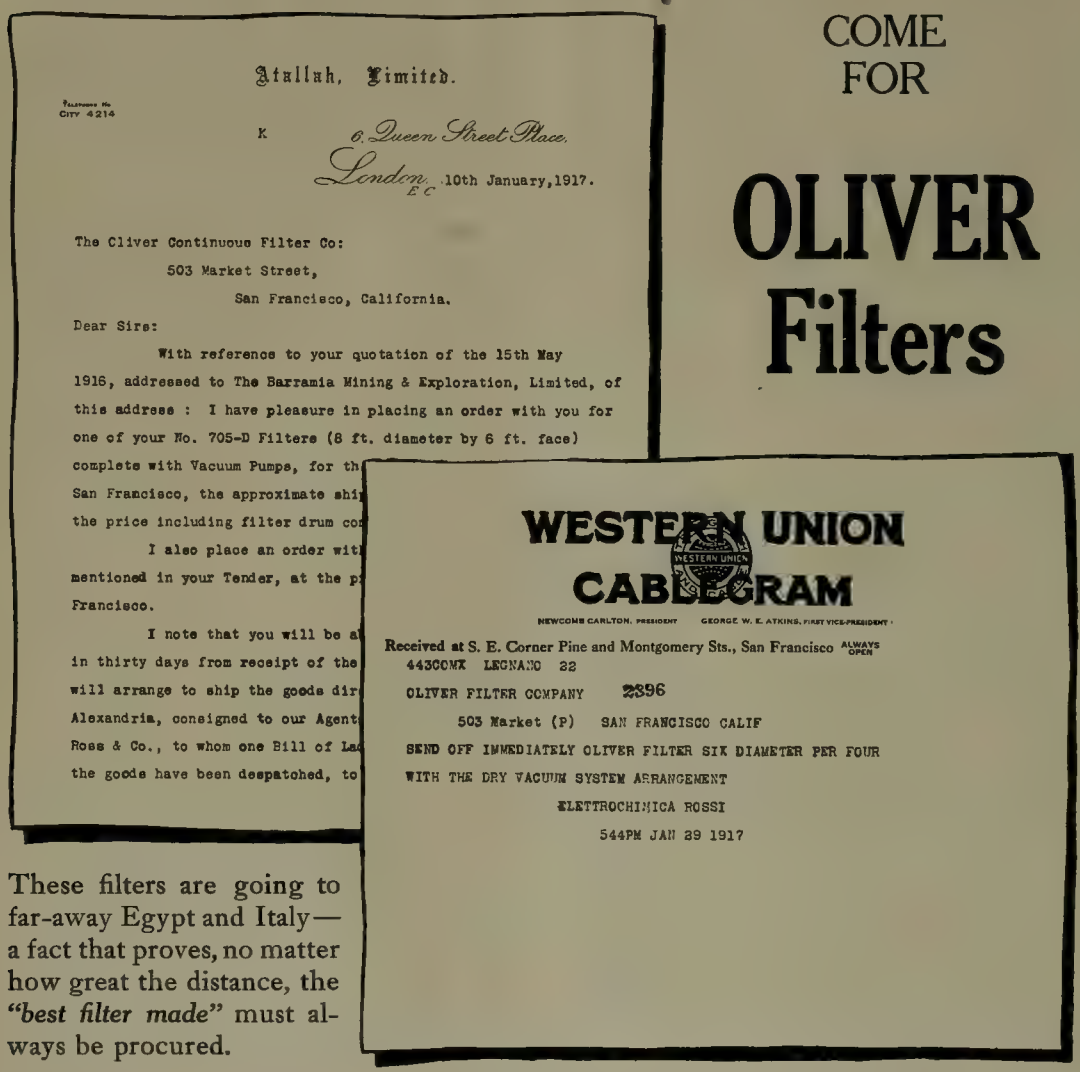

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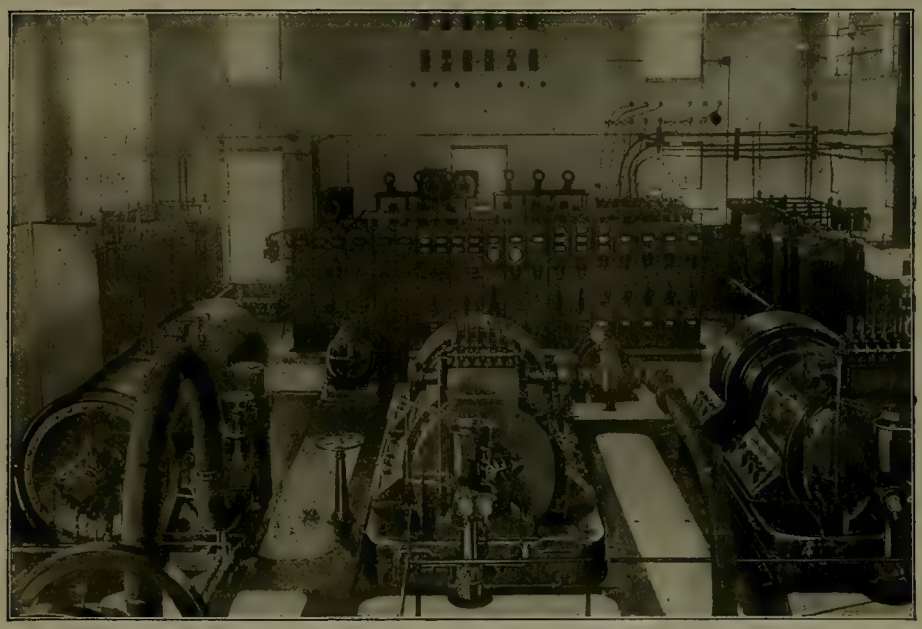

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EDITORIAL

T. A. RICKARD, Editor

LAST year the group of desseminated-copper mines under the Jackling management produced nearly 25% of the American copper output, the aggregate being 220,500 tons, which was 31% more than the same group of mines produced in 1915. Assuming an average price of 25 cents per pound, the joint product was worth about $110,000,000.

DURING the three days beginning on February 19 the American Institute of Mining Engineers will hold its annual meeting in New York City. We note that the occasion is to be used to hold a re-union of Harvard mining engineers and geologists on February 19. Such foregatherings of friends fulfill one of the chief purposes of the Institute meetings.

SHORTLY after this issue reaches our readers they will learn who has been elected President of the American Institute. We hope, whatever the result may be, that the candidate not elected will be nominated and elected without opposition for the following year. This is suggested in the best interests of the Institute and in the hope to avoid the recurrence of competitions not in keeping with the dignity or welfare of the profession.

FREIGHT-RATES across the Atlantic have become a vital factor in the foreign copper trade. Before the diplomatic break with Germany it cost $75 per ton to transport copper to Mediterranean ports as against a $4 rate just before the beginning of the War. Insurance was quoted at 10%. To French ports the freight-rate was $45, as compared with $2.50 or $3 per ton in normal times. The British government has taken freightage to England into its own hands. At the present time traffic across the Atlantic is practically in abeyance.

IN our last issue a typographical error was made when comparing the output of gold in the Transvaal in 1916 and 1915. In 1916 it was 9,295,538 ounces, worth £39,484,934—the highest on record—and in 1915 it was 9,093,671 ounces, worth £38,627,461, so that the gain last year was £857,473 or $4,158,875. The gain made by 1915 over 1914 was £2,970,000 or $14,404,500. In 1916 the total of dividends declined further, being estimated at £7,300,000 as compared with £7,824,799 in the year preceding. These changes are due to the impoverishment of the older mines of the Rand without an adequate gain in output and profit from the younger enterprises. The best showing is made by the Modderfontein group, including the Government Areas, which doubled its milling plant during the year. The East Rand Proprietary has never recovered from the fiasco of 1911 and went further down-hill during 1916. Subsidences underground, producing air-blasts, have continued to handicap the Village Main Reef. The Randfontein Central has improved its output notably, thanks to better management. On the whole, however, the story of the Rand in 1916 serves to remind us that the greatest of all goldfields has passed its zenith.

IN December the sale of the Tyee copper smelter, at Ladysmith, on Vancouver island, was reported as having been sold to American capitalists for $275,000. Various interests were credited with the transaction, notably the Guggenheims and the Consolidated Company at Trail. It appears now that the purchasers are a group that includes Mr. F. A. Sieberling, president of the Goodyear Tire & Rubber Company. Additions and alterations to the plant are being made under the direction of Mr. W. J. Watson with a view to increasing its capacity to 1000 tons of ore per day, as compared with the former capacity of only 600 tons daily. It is understood that a supply of copper ore is to be derived from the Mount Sicker mines in British Columbia and also from sundry Alaskan copper mines, as well as from customers elsewhere on the Coast.

EXCESSIVE taxation has caused the Canadian Mining Corporation, controlling the Cobalt Town Site, Cobalt Lake, City of Cobalt, and other properties at Cobalt, Ontario, to change its registry from England to Canada. It is stated in a circular to the shareholders that the advantages to be gained by the transfer will be (1) an active share-market at New York and Toronto, as well as London, (2) economy of management, and (3) conversion into dollar shares. The real grievance is the double taxation, namely, the English income-tax on profits remitted to London and the Canadian taxes. There is also an idea of escaping any future liability on the excess-profit tax. In London the action of the corporation is deemed unpatriotic and the *Financial Times* suggests that the Treasury or the Stock Exchange committee may forbid dealings in the new Canadian shares until after the War.

STEPS are being taken by the Minerals Separation people to exact royalty from those not licensed by them to use the froth-flotation process. We publish a copy of the letter sent by their lawyer to various mining companies, together with the list of questions the latter are ordered to answer. The tone is mandatory and per-

emptory. Some of the questions are inquisitorial and unwarranted. It is no business of Minerals Separation what "type and manufacture of apparatus" is used by anybody. The Supreme Court has upheld the validity of patent No. 835,120, but defined it closely, and under that definition no embargo is placed on the use of any machine unless it involves the application of a process employing less than 1% of oil and the 'beating-in' of air. Again, the demand for particulars concerning "any flotation tests" made on the ore is quite outside reasonable curiosity—it is an impertinence. The object evidently is to obtain information for the use of Minerals Separation and to discover the names of metallurgists engaged in experimental work, in order to put them on a black list. Thus the company is continuing its maladroit methods of antagonizing those engaged in mining and of creating an intensified opposition to its alleged monopoly. The Miami appeal has been heard before the higher court at Philadelphia and the suit of Minerals Separation against the Butte & Superior company comes to trial at Butte on March 19. New evidence will be presented by the defendant. At the same time the question of damages due to Minerals Separation will be adjudicated. We have not heard as yet of any injunctions having been granted against mining companies since the Supreme Court decision.

SHAFT-SINKING is always an interesting process, particularly the methods employed in doing fast work. Two records of rapid sinking have attracted the attention of mining engineers. One of these comes from the Tintic district of Utah, where the rectangular shaft of the Chief Consolidated mine was sunk 261 feet in 31 days. The shaft has two compartments 50 by 50 inches, and one compartment 50 by 38 inches. It is protected by 8 by 8-inch timbers. Sinking progressed at the average rate of a little over 8.42 feet per day. The rock penetrated was limestone in thin layers. The total size of the rock-cutting we estimate at 15 ft. by 6 ft. 4 in., which includes 2-in. lagging and the usual allowance for clearance between the outer walls of the shaft and the rock. This indicates a sectional area of 95 square feet. The other record was made at the Crown Mines on the Rand, in South Africa, where a circular shaft 20 feet in diameter was sunk, through quartzite, 252 feet in 30 days —an average rate of 8.4 feet daily. This is almost exactly the same as in the Tintic shaft. The sectional area of the Crown Mines shaft is 314 square feet, or three and one-third times larger than the other; consequently the shaft on the Rand was really a much bigger job than the one at Tintic. However, a shaft of such large size permits of greater freedom of operations in some ways, and the effective working of a greater number of men per square-foot of area. On the Rand, too, the matter of timbering does not retard progress, as the bottom of a shaft there is often 100 feet or more in advance of the last set of timbers. Both of the shafts above-mentioned are notable examples of what may be accomplished in mining under competent supervision.

DISCUSSION this week is again varied and interesting. Mr. David Cole returns to the fine-grinding experiments at the Inspiration mill and traverses the remarks of Mr. C. T. Van Winkle, of Salt Lake City. By the way, this Mr. Van Winkle should not be confused with a gentleman of the same surname interested in the sale of a grinding-machine and resident in San Francisco. Mr. Cole finally disposes of the controversy over the test between the Hardinge pebble-mill and the Marcy ball-mill, and describes the Hardinge ball-mill, now about to be tried against the Marcy mill, which has done such good work at the Inspiration. The results of this competitive test will not prove which machine is best for *all* kinds of ore; but it will be most useful in suggesting a further development of this type of grinder. Our friend Mr. Jacobs, an acknowledged authority on British Columbian mines, demurs to sundry statistical statements and makes a correction of some figures quoted by us from our usually well-informed contemporary, the *Boston News Bureau*. Mr. C. S. Parsons writes from Ottawa to contribute a useful note on the use of caustic soda as a deflocculent in the flotation process, and we thank him for it. Mr. Maurice D. Leehey, as a lawyer versed in mining litigation, particularly in the Northwest, discusses the friendly controversy between Mr. Winchell and ourselves. He contends that no law can be devised that will prevent disputes over its intent and he expresses a reasonable fear that Congress may be driven to the making of dangerous experiments, more particularly the placing of our mineral lands under a leasing system—an idea that is strongly disliked throughout the West. So he cautions the mining community against insisting upon any radical change in the existing mining law. Then follows Mr. W. H. Storms, who, as a former State Mineralogist and a mining engineer of mature experience, also submits objections to setting aside the extra-lateral right. He likes the Mexican law, with its vertical planes of limitation, and the facility for locating a large area temporarily, until the locator can ascertain, by prospecting, how much ground he will require on the dip of the vein or lode. Cyanidation is represented by the letter from Mr. P. R. Whitman, who discusses the successful application of counter-current decantation at Porcupine, apropos of the excellent paper recently contributed by Mr. L. B. Eames. Mr. Whitman gives some useful data concerning similar work done nine years ago in Mexico, and we hope that his notes will provoke the former managers at the Indé to add to the information furnished by him. The 'Pertinent Questions' asked by 'A. B. C.' draw further replies from Messrs. George Jackson and S. H. Brockunier. The former records a feat in tramming that may provoke comparisons. 'A. B. C.' himself makes some practical comments on the replies made in previous issues and tells us about foremen that pooh-pooh systematic methods. We take pleasure in giving space to an appeal made by a committee of the American Association for the Advancement of Science asking for the co-operation of industrial laboratories in the great work of scientific research. The

names of the men on this committee will give weight to the appeal. An ancient topic, the black sand of the Pacific coast, receives the intelligent attention of Mr. Jacob W. Young, who writes from Alaska to describe his own useful experience in the treatment of this product. He supplements Mr. Herbert Lang's valuable article on the subject.

Metallurgy of the Rand

In this issue we are fortunate in being able to give our readers an article by Mr. H. Foster Bain discussing and criticizing metallurgical practice on the Rand. This critique is based on observations made by him during a recent visit to South Africa. It is kindly and it is meant to be useful. Evidently not much adverse criticism is possible, for a recovery of 95% of the assay-value of the ore speaks for itself, but the average reader will be surprised to note that about 64% of the gold is still extracted by means of amalgamation, although the plates are placed after the tube-mills. Mr. Bain conveys to us his own impression of the bigness of the operations by comparing the daily output of some of the leading mines of the Rand with well-known properties in the United States. He also corrects the general impression that the ore of the Rand is unusually low-grade. A $6 ore would be considered rich at Treadwell, Juneau, Calumet, or Deadwood. The ore is relatively docile. The metallurgical problem is mechanical rather than chemical. Mr. Bain offers some interesting comment on the cost of milling, comparing it with other regions in which native labor is employed and with districts in which all-white labor is available. Apparently the chief factor in promoting economic reduction has been the development of crushing machinery to pulverize a hard ore, and this has been done mainly by the judicious use of the tube-mill so as to save the stamps that part of their duty that they are least fit to perform. Mr. Bain's discussion of the ball-mill is particularly timely, having regard to recent controversies over the use of it in copper-concentration. It has been suggested that ball-mills of large diameter, say, 10 or 12 feet, would be the most effective crushers for Rand ore. They should have steel liners, but no balls, the grinding being done by the ore itself, fed for this purpose up to, say, 8-inch cubes. The coarseness of the gold in parts of the banket has stood in the way of crushing with cyanide solution. Mr. Bain's remarks on this point will be appreciated. Even those that oppose crushing in cyanide solution, followed by amalgamation, will approve of an effort to reduce the cost of grinding to a level where it will be economical to reduce all the ore, say, to 80% through a 200-mesh screen. The logical step then would be amalgamation followed by direct treatment of the whole product in Merrill presses, as is done with the slime at the Homestake, or crushing in cyanide solution—without amalgamation—and continuous thickening, agitation, and filtering of the all-slimed product. Mr. Bain's reference to the lack of attraction of air-bubbles for particles of free gold is surprising, for our understanding is to the contrary. His suggestion to make a small proportion of high-grade concentrate by flotation is sound. We hope some of our readers will contribute their opinions on these matters. Coarse gold, of course, will not float if the particles are so large that gravity overcomes surface tension. The familiar needle experiment fails with a large needle. On the other hand the floatability of fine gold is one of the axioms of milling. The treatment of the flotation-concentrate by cyanidation offers sundry difficulties—such as the oil—but these are now being overcome in many laboratories and we may count confidently on a satisfactory solution of the problem. In regard to the further use of Dorr thickeners on the Rand, we are informed that it will depend chiefly upon the ability of these most useful machines to deliver a slime containing less moisture than at present. Recent experience in the United States indicates that by using Dorr trays as much as 7800 square feet of effective settling-area may be obtained from a 50 by 12-ft. vat; this is about double the settling-area of the standard 70-ft. vat used on the Rand. Such concentration of area suggests the practicability of housed vats, and the improvement of both settling and precipitation during the winter. Mr. Bain's comment on the distribution of labor between mines and mills will be appreciated at Johannesburg. We agree with him that the monotony of treating the same kind of ore year after year, and also the lack of variety in the composition of the outputs from the various mines in the district, serves to diminish interest in local metallurgical practice and to deter ambitious young men from spendng many years on the Rand. We hope that Mr. Bain's pertinent criticism of one phase of the mill-management will reach those for whom it is intended. Such criticism is invaluable. We trust that the whole of his article will be taken in the kindly spirit with which, we know, it was written. In these modern days the engineer is favored with tons of descriptive matter on technical subjects—enough to provoke mental dyspepsia—but the proportion of judicious and timely criticism is lamentably small. The profession will welcome more of it; for only by aid of it is real progress attainable.

Short-Selling

The selling of shares that one does not hold has been defended lately by so eminent a financier as Mr. Otto H. Kahn, and the financial press has accepted his lead, publishing a great deal of flapdoodle in defence of an essentially iniquitous practice. The *Wall Street Journal* suggests that the market-man who sells 500 cantaloupes to the Waldorf for a coming banquet may not have a single one in his shop; he anticipates the arrival of a consignment from the South-west, in order to 'cover his shorts.' But the cantaloupe-dealer is not using the fruit as a mere counter in a gamble, he is a middleman between the producer and the consumer. The attempted analogy cannot be accepted. The *Journal* proceeds to call short-selling a "market stabilizer and a great convenience to the public"—which provokes a smile. The customers

are induced by the bucket-shop tout to 'invest' on a rising market and are encouraged to pyramid their commitments until the margin of safety is passed, whereupon the predatory broker starts selling short and smashes the quotations, making a fairly safe profit. That is why the public figures as a 'lamb' among the 'bears' on Wall Street. The simile is born of much observation. Most of such unscrupulous brokers will not take an order to sell short, because a short sale requires delivery within 24 hours and the broker is usually on the other side of the deal. The idea is to keep the greedy and gullible public in the corral until it has been sheared. On declining markets the bucket-shops go broke. In an article by Mr. Albert W. Atwood, appearing in the *Saturday Evening Post* we have an example of the way in which a mine is used as a means for such chicanery. Its value, or lack of value, played no part in the story; the mushroom brokers, their 'house organs' or circulars, a complacent press, and the eagerness of ignorant people to become rich were the factors that counted—not the mine. Such sordid little melodramas are being played every day just now. It is well that the subject should be ventilated. *The Times*, of New York, said recently: "The fact remains that short sales tend to decrease the value of another man's property." That is why the 'short' is so deservedly unpopular. A gambler that goes bankrupt on a bear deal is rated as a man that plays a mean game, for he stands to lose little and gain much, and in the gamble he may injure a great number of innocent persons. To succeed he does not hesitate to lie; in order to depreciate the stock he attacks, he employs devious ways of manipulation. The idea that his performance—or that of a 'bull'—creates industry is one of the silly myths that the broking fraternity palms upon a simple-minded public. The gambling on Wall Street no more creates legitimate industry than Monte Carlo. Speculation is the essence of adventurous enterprise, such as mining, but the risks attendant upon such useful activities are quite enough without foisting upon them the tricky gambling of a faro-table or the legerdemain of a three-card sharper.

Belgian Relief

We offer no apology for discussing a subject that must command the interest of the engineering profession in the United States not only because the members of it are the least provincial of men but because one of themselves, Mr. H. C. Hoover, has been the originator and chief executive of a noble effort "to write a page of true Americanism in Europe." If foreigners have jibed at our making money while modern civilization was being sent to the shambles, we have tried to salve our consciences by pointing to the splendid work done by a group of American engineers in Belgium. Some have solaced themselves with the idea that the American people had financed the great benefaction, but Mr. Hoover himself has disclosed the innermost finance of the Relief Commission, informing us that out of $250,000,000 contributed for the purpose only $9,000,000 has been subscribed in the United States. As against that the Commission has spent $150,000,000 in the purchase of supplies in this country, and on these purchases a profit of $30,000,000 has been made, so that the United States is $21,000,000 richer for Mr. Hoover's work. These figures might make us feel poorer in spirit if we did not return to our pride in the generous initiative and executive ability displayed by the members of our own profession in Belgium. Surely the time has come—if not too late—to give official recognition to the work. Mr. Hoover said recently that he and his coadjutors have always felt that they were "performing a national service, that it was not only a duty and a responsibility to save human life and avert suffering, but that it was a privilege to do it in the name of the American people, and to do it in a big, generous, and efficient way." Recently we made a special appeal, in behalf of a group of representative mining engineers, for funds to succor the children of Belgium. The response has been good, because many have contributed, but the amounts have been small and the big donations from rich men have been few. We quote Mr. Hoover again: "I have no patience with those who appeal only to the emotions. The man who is swayed by his emotions is usually a man of small intellect, and the man of small intellect is always a man of small pocket-book. Help we need from all classes, but our main appeal must be made to the men who have made America what it is, the big constructive men, the men of brains and wealth." With that we agree; emotional excitement will not help the little ones in Belgium, but the mining engineers and speculators that have made huge sums of money, running into millions, by reason of the big rise in the prices of metals, *they*, can help in a substantial way—and they ought to do so. Mr. Hoover says: "The justification of America's wealth can only be her requital of the obligation which comes of riches, and this requital should not be only her duty but it should be her crown." These quotations give some insight into the character of the man by whom they were uttered. He ought to be backed whole-heartedly by the people of the United States and by the Administration at Washington. Just now the work of the Commission is menaced by the rupture between this country and Germany, and by submarine piracy. If war follows, no American will be able to remain in the German province that was Belgium.

Since writing the above we have received the news that the German government has told the Commission to get out of Belgium, leaving Mr. Brand Whitlock, the American minister, and one or two others to exercise some supervision over the work. We hope that a means will be found for continuing the benefaction, but it must be confessed that the outlook is gloomy, for the confidence of the Allies that the food goes to those for whom it is intended will be lessened and the German authorities may seize the supplies—valued at $25,000,000—now stored by the Commission in warehouses distributed among the various districts of Belgium.

The Struggle for Gold in Russia

*While the financial leaders in the United States are worried over the vast amount of gold in the country, now about $3,000,000,000 and the steady influx, which was $1,000,000,000 in the last two years, other countries are desperately striving to increase their store. Russia especially is worried about the leakage of gold across her frontier. This leakage is stimulated because the foreign buyer has his gold minted free while the Russian mint charges in all 8%, of which 6% is illegal. The gold produced in Russia and Siberia is surreptitiously bought by Chinese and German agents, who pay a much greater price than the Russian mint. The leakage is also stimulated by lessened smaller transportation charges and speedier returns by the foreign buyer as compared with the dilatory procedure of the Mint. Moreover, much gold is produced by 'poachers' who naturally smuggle it out of the country. The remedy suggested is for the Government to buy the gold at the place of production and pay the market-price.

Complaint is made of the unfair practice of the Mint, which is legally bound to buy gold offered in quantities of not less than a quarter of a pound and to pay for it within three days, less a fixed charge of 2% for assaying, refining, and coining. But when dealers deposited gold (in 1915) they found to their astonishment that a further deduction of 6% was made, and no explanation was given for this additional charge—it was a mere caprice. These charges and the payment for the gold at less than the market rate caused such a loss of gold that in September 1915 a council of ministers issued regulations for the payment of such a premium that there should be no profit in the exportation of gold to China, but the premium was fixed at 30%, or much less than was paid by the Chinese buyer. Hence the leakage continued. Besides paying a larger price for the gold the Chinese buyer made a settlement within a few hours while the Mint took as long as four months. One writer says that it is easy to stop the outflow of gold: all that is needed is to pay the market price promptly; but he fears that nothing can be done, for although an Imperial order was issued in October 1914 to increase the production of gold nothing had been done for a year. However, a decree allowing the free importation of dredges and their parts was subsequently issued and it is hoped that this liberal measure will increase the output.

A committee for furthering gold mining has decided that the purchase of gold must be organized in places near the mines and that, in the first instance, post and telegraph offices must be used. As a safeguard, 2% of the estimated value of the gold should be retained. Financial, economic, and judicial commissions are to be formed for investigating the gold industry. The question of modifying gold-mining regulations and the necessity for obtaining prisoners of war for work on roads were considered. No decision was made about the free admission of Chinese laborers in the mines of Eastern Siberia; this admission was demanded by the operators and opposed by the bureaucrats.

According to an article in the *Rhein. Westfalische Zeitung,* quoted in *Zoloto i Platina,* elaborate plans for enticing gold from Russian and British producers was developed by a special commission of the German Imperial Bank. By this plan illicit-gold miners in Siberia, private buyers of gold, and agents of the German government are to be induced to collect gold for German use. German consuls are instructed to issue special appeals to illicit-gold miners in their own language and to pay a higher price than that ruling at the mines. Special agents are to be hired at a fixed commission. Private buyers are to be attracted by giving special credits and by speedy payment for the gold; and by the payment of a premium, which in July 1915 was about 1.25% for those delivering about $10,000. German and Austrian subjects who buy gold are given large credits and stimulated by honorary titles, orders, and privileges. Buying of gold is carried on by all banks, insurance companies, post, telegraph, and telephone offices; steamer, railway, and forwarding agents; doctors, judges, pastors, custom and frontier authorities, and the Government agents that are found in all German firms; to assist in this work local consuls are obliged to open credits. Tables have been prepared, and sent to all consuls, giving the assays of gold from various districts. These tables include minute subdivisions; for example, the Amoor region is subdivided into 14 districts; Manchuria into 22; Belgian Kongo into 65; British East Africa into 17 districts. This system enables the Germans to make a close approximation to the value of the gold offered. In Peking, Cheefoo, and Shanghai the Germans have built permanent laboratories in which careful estimates of the value of the gold are prepared and a final settlement is then made with the sellers, who are in the first instance paid about 95% of the supposed value.

*From *Zoloto i Platina,* translated and abstracted by W. H. Shockley.

TUNGSTEN MINERALS were produced in the United States in the first half of 1916 to the value of $9,112,000. Of this 1495 tons was ferberite, all of which came from Colorado, and valued at $3,590,000; 1404 tons was scheelite, having a value of $4,322,000; 201 tons of wolframite sold for $613,000, and 185 tons of hübnerite for $587,000.

GOLD received by the San Francisco Mint in January totaled 415,449.795 oz.; silver, 103,243.01 oz. Coinage executed was 290,000 half-dollars, 1,500,000 quarters, 320,000 dimes, and 400,000 cents. The vaults contain $443,601,618.43. Since its inception the local Mint has coined money to the value of $2,022,140,686.87.

Adaptation of Mining Methods to Geology and Topography

*The methods of prospecting and mining adopted by the Chino Copper Co. in the Santa Rita district, New Mexico, have been determined by the geologic features of the ore deposits, and the general scheme of excavation, ore delivery, and waste disposal has been well adjusted to the topographic situation.

By reason of the wide extent of the orebodies as compared with their depth, they were well suited to churn-drill prospecting for the determination of quantities and grades of ore. The altered and generally soft nature of the rocks resulted in low drilling costs, and the relatively even grade of the ore favored accuracy in determining its copper-content. The feasibility of open-cut mining by means of steam-shovels depends on the size of the deposits and the thickness of the overlying waste. Because the altered rocks that contain the ore and constitute the gangue are soft, drilling is easy. These rocks are much jointed and break readily when blasted. Any appreciable addition to the amount of waste material that must be moved, owing to large slides, is not anticipated. In general, the overburden of soil, or unconsolidated débris, is shallow; and everywhere such material is essentially free from percolating water. Overburden consisting of weathered rock is also well drained, and both materials stand well without 'slaking' in any important degree. Although the ore and the weathered rock contain abundant sericite, and when finely broken develop much colloidal material, in place they are generally strong enough to stand with fairly steep slopes for all depths that are reached by open pits.

The mines are situated in a basin which is a broadened section of the valley of Santa Rita creek. In plan the outline of the Santa Rita mine workings is like that of a jew's-harp, two great cuts forming the flaring loop, the block left to carry the creek forming the tongue. The creek flows south-west, leaving the ore-bearing area 4000 ft. beyond the point of entry and at an elevation 120 ft. lower. The inclined approaches that permit locomotive haulage in removing the ore from the deep pits have grades opposed to the general surface slope. These approaches diverge at a point more than 1200 ft. down stream from the western edge of the ore area. The length of haul from the far end of each of the mine pits to the common track that serves the crushing-plant is thus greater than a mile, so that considerable depths can be directly attained. Eventually spirals or switchbacks will be required, and possibly the use of hoisting-planes or Shay geared-locomotives may be advantageous. At present the development plans of the company do not contemplate that any mining will be done by means of steam-shovels below an elevation of 6050 ft., which is approximately 150 ft. below the points where the pit approaches intersect the ground surface.

The crusher is situated near the mouth of the canyon-like valley that drains the Santa Rita basin, the delivery track being at a level about 80 ft. above the assembly yard. From this yard the ore-trains go to the concentrating plant at Hurley by way of the Atchison, Topeka & Santa Fe Railroad. Whereas the ore-tracks necessarily converge for the purpose of delivery, the waste-tracks are in the main divergent. The principal dumping-ground is in the valley of Whitewater creek, south of the mines, but most of the waste from the upper levels of the northern section has been deposited within the Santa Rita basin west and north-west of the mines.

Because of the semi-arid character of the climate, current ground-water seepage is slight in comparison with the extent of the workings, and pumping-costs are correspondingly low. At times of heavy rains the lowest levels in the pits become flooded, but little time is lost from this cause. Continued rains, which are seldom experienced, result in reduced operating efficiency, mainly by causing track troubles. For some time to come a channel for the creek will be maintained directly across the Santa Rita basin, but eventually, in order to remove large quantities of ore, the diversion of the stream will be necessary. Occasionally after heavy rains the volume of water carried by the creek is large, but the mine pits have been so planned that they are in no danger of being flooded from this source.

The Chino company has, for convenience of reference, grouped its property into six orebodies, as follows: C. Y. B., Sierra, Hearst, R. W. T., Old Fort, and Estrella. This grouping, however, is somewhat artificial and the divisions do not correspond in every case with actual breaks in the mineralized area. In fact some of the orebodies are somewhat merged with each other and some are separated by areas of mineralized but low-grade rock.

*Abstract from Bulletin 107, U. S. Bureau of Mines.

THE GOLD MINES OF THE WORLD produced, 35 years ago, in 1881, about $103,000,000. The production for 1916 will be over $450,000,000. The total estimated production of gold in the world to date is in excess of $12,157,000,000, of which about $8,000,000,000 is in the form of coin. The balance is in use in the arts, or has been irretrievably lost.

SINGLE-ARM cams permit a greater number of drops of a stamp without camming than is possible with a double-arm cam, when each has the same height of drop. All of the early stamp-mills were equipped with single-arm cams, after the iron cam-shafts and steel cams came into use.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Fine Grinding at Inspiration

The Editor:

Sir—I have read Mr. Van Winkle's discussion of my late attempt to reflect, for the benefit of your readers, the situation now prevailing in regard to "fine grinding in the Miami district," and while I deplore his attitude and tone of voice, so to speak, I believe with him that your readers may be interested in an explanation of the difference between a real Hardinge ball-mill and the pebble-mill that has been under discussion.

The particular Hardinge mill referred to by Mr. Van Winkle as "used in competition with a Marcy mill during December 1914 at the Inspiration test-plant" was an 8 ft. by 36-in. machine made with a sectional cast-iron shell, was equipped with 10-in. face herring-bone gears, and was driven by a 75-hp. motor direct-connected to the pinion-shaft through a flexible coupling. The feed-scoop and throat-opening were designed to handle material previously crushed to ¾ in. or smaller. The mill was lined with pebbles set in cement. When fully loaded this machine carried five tons of flint pebbles as the crushing medium, and used 56 hp. (input to motor). The unit was served by a drag-belt classifier adequate to return the oversize when working under normal pebble-grinding conditions. The weight of this mill and motor (not including the load of pebbles) was approximately 26,000 pounds.

The Marcy machine being used in the test-mill at that time was an 8 by 5-ft. machine carrying a very heavy manganese-steel lining of the Krupp form, and using ten tons of chrome-steel balls fed to the mill at five inch diameter. The mill was belted to an electric motor and consumed 180 to 200 hp. (input to motor). The feeding devices were ample in size to 'take' coarse feed up to three inches, and the unit was served by a duplex Dorr classifier for returning the oversize. The results were very attractive from the first, and it was realized that the Hardinge mills that had long been in use did not in any wise provide parallel conditions, but to satisfy curiosity the mill first described was emptied of its pebble-load and manganoid (cast-iron) balls were substituted. Shortly after starting with the ball-load the pebble-lining came out, and a survey of the situation showed that in order to put the Hardinge machine upon a basis wherein results would be comparative, it would be necessary to re-design it entirely; to provide first, a steel lining adapted for the use of iron or steel balls; second, gears and motor capable of standing up under the doubled load; third, feeding facilities (scoop and throat) that would handle coarse feed; and fourth, to increase greatly the capacity of the apparatus for returning oversize. To carry out this program would take more time than was then allowable and the experiment was therefore discontinued.

No engineer has previously regarded this work in the light of "competition." The management did not so consider it, and to refer to it as Mr. Van Winkle has done is absurd. References of this kind are responsible for the erroneous impression that had gone abroad, and it was to correct in some measure this obvious wrong that I was moved to write what I did under the caption 'Grinding Mills at the Inspiration' in your issue of December 9.

I have not the remotest interest in the manufacture or sale of the Hardinge, Marcy, Marathon, or any other 'fine grinder,' but I do love truth and fair-play. I know that the experiments now approaching the period of fruition in the South-west are intended to bring out the facts in regard to the competing machines and to do it with the minimum color of prejudice. The results will not be "conclusive" in the sense that Mr. Van Winkle assigns to my remarks, but to those who are confronted with grinding problems, the records about to be made will be sufficiently so for the moment at least.

The following table shows the weight, power required, load, etc., of the two types of Hardinge mill, and also the Marcy mills as being used at Inspiration at present:

	Hardinge pebble-mill	Hardinge ball-mill being installed at Inspiration	Marcy mill now in use at Inspiration
Size of mill	8 ft. by 36 in.	8 ft. by 36 in.	8 ft. by 72 in.
Size of motor	75 hp.	150 hp.	225 hp.
Weight of unit empty (with motor)	26,000 lb.	52,000 lb.	104,000 lb.
Weight of charge (pebbles or balls)	5 tons of pebbles	10 tons of balls	15 tons of balls
Power used, full load	56–57 hp.	120–130 hp.	200–225 hp.

The 'size' of the Hardinge mills is the dimension of the cylindrical portion of the shell, and in the Marcy mill the diameter and length of cylinder are given. There is a screening-diaphragm in the Marcy machine

that shortens the grinding-chamber; therefore, the cubic contents of the grinding-chamber is less than the dimensions would indicate. In the Hardinge mill the grinding-chamber is larger than the dimensions given would indicate, because the balls or pebbles occupy the cone as well as the cylindrical part of the mill.

El Paso, January 23. DAVID COLE.

Canadian Copper Production

The Editor:

Sir—The information relative to Canada, quoted in your issue of January 27, from the *Boston News Bureau* and purporting to "include all the mines that produced over 1,000,000 lb. of copper during the past year," is incomplete so far as British Columbia is concerned. This province is credited only with Granby Consolidated 45,484,142 lb. and Consolidated Mining & Smelting 4,446,080 lb. It may be that the latter amount includes the copper obtained from 16,400 tons of ore from the Le Roi No. 2 company's Josie group, at Rossland, and 4400 tons from the Iron Mask mine, at Kamloops, together estimated at not less than 2,000,000 lb., which, however, is doubtful. It is certain, though, that nearly 3,000,000 lb. produced from British Columbian ores through the B. C. Copper Co.'s smelter at Greenwood; about 19,000,000 lb. from the Britannia and Marble Bay mines in the lower Coast district, and between 2,500,000 and 3,000,000 lb. from the Rocher De Boule Copper Co.'s mine in the Skeena country (Omineca mining division) were not included by the *Boston News Bureau*. Deducting 28,000,000 lb. shown as the production of the Canadian Copper, which I take to be an Ontario producer, there remains a little less than 50,000,000 lb. for British Columbia's share of the total for Canada quoted by you. Figures supplied to me (by the producers) for use in making up my annual estimate of mineral production show that the output of copper from British Columbian mines in 1916 was not less than 70,000,000 lb., so I have no hesitation in requesting you to make it clear that by unintentional omission the copper production of this province last year was shown by the *Boston News Bureau* as having been about 20,000,000 lb. less than it actually was.

Victoria, B. C., January 29. E. JACOBS.

Caustic Soda in Flotation

The Editor:

Sir—In the December 30 issue of your paper it is stated that caustic soda is added to the flotation pulp at the Tul Mi Chung plant of the Seoul Mining Co. in Korea. The reference goes on to say that the caustic soda flocculates the colloidal slime and allows the oil more free access to the mineral particles. My own experience has been that the caustic soda, instead of flocculating the slime, deflocculates it. The mineral particles that were locked up in the floccule of slime are set free, which allows them to be more easily oiled. Before the caustic soda was added the oil had to penetrate the floccule of slime in order to reach the mineral particle.

Nearly all ore particles carry a negative electrical charge, hence when caustic soda is added the hydroxyl ions are absorbed into the floccules, causing them to break up and liberate any contained mineral particle.

I have experienced cases where the addition of caustic soda to the flotation pulp has not only increased the extraction but has improved the grade of the concentrate by over 300%.

Ottawa, January 12. C. S. PARSONS.

Revision of the Mining Law

The Editor:

Sir—I heartily commend the editorial comment in your issue of December 23 upon the proposed revision of the mining law. I regret that to do so compels me to take issue with my esteemed friend, Horace V. Winchell, for whose versatile talents I have long had such an enthusiastic admiration, and I should be sorry to have him classify me among those "shrouded in the densest ignorance of the subject." His quotation from Judge Dickson does no violence to your statement that the present law "has been filtered through the courts until its intent is clear." The intent of the law is made reasonably clear by the numerous court decisions, but it is still true, as Judge Dickson says, that "its true meaning or interpretation is still unsettled as to many questions." So is the interpretation of our national banking law and of the Interstate Commerce acts "still unsettled as to many questions," and this is evidenced by the numerous cases constantly arising under those laws. The trouble is that the advocates of general revision imagine a perfect law can be enacted, one whose language will be so clear that no disputes can arise under it. No lawyer need be told it is impossible to express such a law in our language. The framers cannot anticipate every question that may arise under a law, and even if they did, words cannot be arranged to express the rule completely and without ambiguity. And even if this could be done, it is impossible to bring about the enactment of such a law, especially under conditions existing in Congress, where such a law must be passed by men 90% of whom know absolutely nothing about mining or public-land conditions. To this situation we might apply the remarks in your last issue upon the subject of simplified spelling. No doubt our spelling could be simplified and improved, and we are just as likely to obtain an ideal system of spelling as an ideal code of mining laws.

But the great objection, from a Western standpoint, to any general revision of the mining laws at this time, is that such revision will be made by a Congress which is both ignorant and unappreciative of the fundamental principles involved, a Congress just now far less responsive to Western sentiment than it is to the influence of the well-intentioned but misinformed and impractical theorists who would place all of our public mineral-lands under a leasing system. It would surely result also in

an increase of Federal control and red tape, and limit or destroy the present power of our State legislatures to meet the varying local conditions. Really, I think we had better go slow at this time in changing a law that has stood the test of 45 fruitful years and permitted—if not fostered—that wonderful era of mining development throughout the West.

The great bulk of the unappropriated mineral-lands now left in the public domain are situated in Alaska; hence that territory is vitally interested in any new legislation. From disastrous experience we have good reason to fear any general revision at this time. We have had some trouble over the question of discovery, but so far there has been no case in the courts of Alaska involving the law of extra-lateral rights. This although Alaska, as compared with the States, has for years ranked third as a gold-producer, and now stands fifth in copper, first in tin, and either fourth or fifth in the total production of metals. The apex law has indeed been so well interpreted by the courts that counsel now has little difficulty in advising clients how to avoid its complications—no more difficulty than is presented in applying any other law, for no law has yet been written, or ever will be written, that will be free from doubt in the involved circumstances of every case which may arise under it. We are especially opposed to the bureaucratic suggestion that location notices be recorded in the U. S. land offices, of which there are three in the Territory, and the nearest often more than a 1000 miles, or three weeks, distant. We fear that any revision at this time, no matter how well considered by its proponents, will result disastrously to our interests after it has run the gamut of Congress. The coal and oil lands of Alaska are still tied up, for so far the coal-land leasing law has not proved workable, and Congress has not even passed a law permitting operations in the oil-fields. The one patented oil claim is daily demonstrating the richness of the field, but Congress has not been able to legislate for their operation, and until Congress at least demonstrates the ability to provide the much-needed new legislation for the relief of our forbidden industries, we prefer to get along with our present metal-mining laws.

Seattle, January 16. MAURICE D. LEEHEY.

The Editor:

Sir—I have read the contributions of a number of gentlemen to this discussion, and the more I read these expressions of opinion on the subject, the more firmly I become convinced that some of them, at least, are under the impression that a change in the mining statutes that would abrogate the right to follow the dip of a vein in its downward course beyond the side line of a claim, and underneath the surface owned by another, would affect alike all mines in the West, and that there would be an end, at once, to all side-line litigation. Of course, this would not be the case, as no new law is retro-active, and only those mining claims located after such a new law became operative would be affected by it. In contemplating any change in the law that would eliminate the extra-lateral right, due consideration must be given the necessity for following a vein downward on its dip to any depth that profitable ore may be mined.

As an illustration of this, permit me to call attention to such mines as the Kennedy, Argonaut, South, and Central Eureka, Bunker Hill, Keystone, Fremont Consolidated, Plymouth Consolidated, and other deep mines in Amador county, California. There the angle of dip of the veins is usually between 50 and 60°, and the lower workings of the mines are far out beyond the side lines of the locations that cover the outcrop of the veins. In the case of the Kennedy, which is the deepest, it is fully half a mile from the outcrop to a point vertically over the lowest level of the mine, and this distance will increase as the workings are carried to still greater depth.

In the Grass Valley and Nevada City districts the veins are much flatter than those on the Mother Lode and horizontal distance from the outcrop is gained rapidly with increasing depth. These two districts are mentioned because they may be taken as typical of veins in many other regions elsewhere—the Mother Lode fissures are in slate and amphibolite schist; the Grass Valley-Nevada City mines are mostly in granite, and conditions obtaining in these two localities are analogous to occurrences in other places, where mining locations may still be made on the public domain.

When a prospector discovers the outcrop of a vein, how will the proposed new law provide for him to follow his vein in depth, to a region, say, half a mile or more horizontally distant from the outcrop, and permit him to do so without interference with the rights of others?

It may be argued that the prospector need not concern himself about what may happen in 10 or 20 years, as he, in all probability, will never be able to carry his workings to a depth that will take him so far from his outcrop. This may be true, as to the locator, but if he sells his claim, as he is most likely to do, the only rights he can transfer to his wealthy successor are those derived from his original location. In many respects, the Mexican law, in normal times in that Republic, is superior to ours, and in none more so than in the method of acquiring title to mining property from the Government. The Mexican law provides that a prospector may, on application to the proper authority, 'denounce' (locate) for the purpose of prospecting, as many *pertenencias* (claims) as he deems necessary, for which privilege he pays a stipulated tax or fee. He then proceeds with his investigation and when he has satisfied himself as to the number and situation of the several claims he wishes to secure, he relinquishes all of those he does not consider essential, and thereafter pays the tax only on those he decides to retain. During the prospecting period he has the exclusive privilege of searching for mineral within the boundaries of the tract selected, so he remains in undisturbed possession as long as he complies with the requirements of the law. He acquires no extra-lateral right, but is entitled to all the mineral he may discover within the planes of all his boundaries extended vertically downward. If he can

ascertain the direction of the dip of his vein, he secures in that direction what he believes to be an area sufficiently large to permit him to continue his operations to great depth. This is a law that gives to the miner all that he claims, but no more, and extra-lateral troubles are unknown. In the United States these matters require careful consideration, and when contemplating the chaos that most likely would ensue, following the proposed elimination of the extra-lateral right—if wise provision is not made to ensure the privilege of deep mining—it may be doubted if such a change is really either necessary or desirable.

There are some who say that others may acquire the ground overlying the deeper part of a vein, thus opening a line of 'deep levels,' as is done on the Rand. The argument is fallacious—there is but one Rand, its nearest geological analogy being the Lake Superior copper deposits—and the idea of creating a line of 'deep levels' and a second line of 'deep-deep levels' would not be found to give satisfaction in the West, as it would place an almost insurmountable handicap on deep mining, for only those mines producing an unusually rich ore would be considered as possibly justifying the additional expense incident to the necessary equipment, and the sinking of the deep shafts required to reach the vein at great depth, and beyond the side-line of the outcrop claimant.

Berkeley, January 17. W. H. STORMS.

Counter-Current Decantation

The Editor:

Sir—To some of us who have followed the commercial development of the cyanide process, the successful adaptation of counter-current decantation as exemplified in the practice at Porcupine and a few other districts seems of such vital importance that data concerning it are worth preserving. Apropos of Mr. Eames' interesting article on C. C. D. in your issue of December 30, 1916, and of his comments on early attempts along that line, permit me to state that in 1908 the Indé Gold Mining Co., at Indé, in Durango, Mexico, had the continuous decantation process in successful operation. On the chance that neither Mr. Harris nor Mr. McCart (former managers at Indé) have furnished any data, I may say that the all-slimed pulp from a closed circuit of tube-mills and one of the original Dorr classifiers was thickened in three 15-ft. diam. cones, 60° sides, fitted in the centre, with diaphragm-pumps, making thirty 1⅛-in. strokes per minute. Barren solution was introduced into the closed circuit at the tube-mill discharge and at the classifier sand-discharge. The clear overflow from the cones, assaying two to three grams in gold and ten grams in silver, went to zinc-boxes through a Burt clarifying-filter. The average cone-feed contained 90% moisture, and the diaphragm-pump discharge 55% moisture, thus continuously decanting and precipitating 86% of the solution at its point of greatest enrichment, for, curiously enough, little further solution of gold or silver took place after the thickened underflow went to the agitators and Butters filter. It is my belief that, at the time, we were not aware of other attempts at either continuous thickening or continuous decantation, nor did we altogether realize the full importance of the principle involved in the use of the apparatus as stated. These facts are given solely with a view to their preservation as of historical interest, the writer making no claim whatever to any credit in this connection.

Toronto, January 6. P. R. WHITMAN.

Some Pertinent Questions

The Editor:

Sir—One of the questions asked by A. B. C. is: "How far should a trammer push a loaded car on a fair track underground in one minute?" I should say about 250 feet, or a little slower than the average walking gait. A man walking at the rate of three and a half miles an hour goes 308 ft. in one minute, so the distance mentioned—250 ft. in one minute for a trammer to push a car on a good track—is about right. However, there is a great difference in the energy that men will apply to any occupation, particularly to tramming. I knew one man who used to tram ore on contract at 4 cents per ton, from a loading-chute underground, to a mill. The distance was 600 ft. The car had a capacity of 20 cu. ft.—about one ton of broken ore. The track was straight and good—16 lb. rail—the grade was about five inches to 100 ft.; 250 ft. of the distance was underground. That man generally delivered 90 cars of ore to the mill every shift that he worked. This means that he pushed a heavy car containing one ton of ore a distance of 10 miles, and pushed the empty car back, a distance of 10 miles—20 miles per shift, and he never missed a shift for weeks at a time. Some trammer!

Sutter Creek, February 2. GEORGE JACKSON.

The Editor:

Sir—I am pleased to see that more than one engineer has taken sufficient interest to comment on the questions I asked in your issue of January 13, though it is now evident that I should have stated in the first place, that the questions were intended to refer to the particular mine under the direction of each individual superintendent, as it would be impossible to give arbitrary answers to some of the questions that would correctly apply to all places. As an example, some of the granite in the mines of Tuolumne county is extremely hard, and no miner can drill in that rock as rapidly as in some of the softer formations of the Mother Lode. Also, it is far easier to shovel from a pile of slaty rock broken fine by blasting, than to 'buck' into a lot of hard angular blocks of greenstone, or granite, where the percentage of fine material is small, and where many of the larger pieces must be picked up by hand and thrown into the car. In such material shoveling is difficult, even from a floor, and progress is relatively slower than where the

shoveler has to handle only fine slaty rock mixed with gouge.

In my original list of questions I failed to make any reference to the size of the hat a mine superintendent should wear, as I did not realize that cranial measurement was important, but I see that Mr. Lewis thinks it is. He ingenuously states that his own hat is under seven, though from the style of his writing I think he is mock-modest. It recalls to mind the remark I once heard an old-time preacher make: "Big head, little wit; little head, worse yet."

I once knew a mine-foreman who, like Mr. Lewis, disdained to burden his mind with figures, and who frankly insisted he knew nothing of book-keeping. The superintendent called him into the office one day and showed him, on the books, that shoveling had cost two cents more a ton the last month than the average for several months past, and that the difference represented the wages of eight shovelers. The foreman declared he didn't understand it, and didn't "know nothin' about keepin' books, nowhow," and left the office. Within an hour eight disgusted shovelers appeared at the office with time-slips. The foreman was an eminently practical man, but had neglected to keep a careful eye on the smaller details of the work for which he was personally responsible; but the superintendent—I don't know the size of his hat—did have a grasp of detail and took the method above described, of teaching his foreman something of the art.

A. B. C.

Copperopolis, California, February 5.

The Editor:

Sir—I have just read the letter from 'A.B.C.' in your issue of January 13. Obviously it was intended to start something, as it is hard to believe that A.B.C. had encountered a mine superintendent too ignorant to answer his questions offhand, as applied to his particular local conditions. There is only one question that might bother one, because we do not often have to meet it or use it. It is my private opinion publicly expressed that no man is fit to be a mine superintendent who cannot answer these questions, and a great many more, offhand. They are only a few of the multitudinous questions that have to be answered by any competent mine superintendent each day.

S. H. Brockunier.

Nevada City, January 29.

Research

The Editor:

Sir—The undersigned committee on Engineering of the General Committee on Research of the American Association for the Advancement of Science feels that it is timely to issue the following appeal to the industrial research laboratories of the country.

In the course of work done in the numerous industrial laboratories of America, many physical and commercial constants and data of great scientific interest and value are doubtless arrived at, and which may, for a certain period of time, constitute an asset of considerable commercial value to the particular corporations in question. During this period, everyone recognizes the proprietary right of the industrial laboratories to the retention of this information.

A time frequently arrives, however, when such scientific information loses its commercial value (often by being duplicated in other laboratories), and just at this point we wish to impress upon the industries their obligation to enrich scientific literature with such facts and data, which might otherwise be lost or forgotten.

Some of our industries have been reproached with the suspicion of acting as sponges, in that they absorb an immense amount of useful information from scientific literature without giving any return in kind. This suspicion would be entirely removed if, from time to time, scientific information which has ceased to be of commercial value were contributed by them to its appropriate channel and thus became available to all scientific workers throughout the world.

If any doubt exists as to the appropriate channel for the publication of such scientific data and communications, the secretary of the A. A. A. S., Dr. J. McKeen Cattell, Garrison-on-Hudson, New York, will be glad to act as intermediary and to forward such communications to the proper scientific body.

A. E. Kennelly,
J. W. Richards,
A. Sauveur,
A. N. Talbot,
C. C. Thomas.

Cambridge, January 27.

Black Sand

The Editor:

Sir—I have read with interest the article by Mr. Herbert Lang on this subject in your issue of December 2. It reminds me of the somewhat intermittent investigations that I have made in connection with black sands in various parts of the country.

My idea in making the study of black sand was to see what, if any, gold was actually enclosed within the magnetic particles such as could be picked up by the ordinary horse-shoe magnet, as I had greatly doubted the accuracy of statement which I had read and heard as to the exceeding richness of some black sands, in which the gold, inferentially, if not so stated, occurred as an integral part of the black magnetic granules.

By spreading the black sand thin on a sheet of paper and passing the magnet over it, all of the magnetic particles were removed as well as some mechanically included gold and some non-magnetic minerals. By repeating the operation three or four times so as to eliminate practically all the non-magnetic material and then assaying the resultant magnetic sand, I have found that little or no gold was carried by this material. The results of the assay showed from nothing up to two dol-

lars per ton; more often than not, however, the assay was blank. On account of the tendency of the extremely thin and flaky gold to be mechanically carried to the magnet with the magnetic grains, I am loath to credit the magnetic sand with the higher assay-values obtained, as being that of actually enclosed gold particles.

Black sand from regions where platinum occurs will, after separation with the magnet and assay of the magnetic portion, show platinum in the assay. All of the platinum, however, is not magnetic.

My experience has been that the gold is in a free state, that is, mechanically mixed with the grains of sand, but it is not always bright. While the gold on the Coast, as mentioned by Mr. Lang, would have its surface apparently untarnished because of its having been subjected to recent scouring action, that in the gravel deposits situated inland which have been permeated by mineral-bearing waters and subjected to weathering agencies is sometimes more or less tarnished and discolored. In fact, it is sometimes black from iron or manganese oxides. The saving of this discolored, as well as the bright, gold, which for some reason is not readily amalgamable, is best accomplished by putting it and its containing sand through a pebble or ball-mill, thus scouring the film off the gold and causing it readily to amalgamate. This is the practice on the more modern of the gold-dredges in California for saving the fine gold that is difficult of amalgamation.

If, as Mr. Lang thinks, the gold can be concentrated into one-fifth of the original bulk of the sand by mere screening, the handling of the beach-sand at a profit would seem to be much simplified. The product from screening, if treated on the Wetherill type of magnetic separators, would give clean concentrates of the various constituents of different magnetic permeability. The non-magnetic residue would contain the gold, and part of the platinum—if any was contained in the original material. The magnetic platinum would be with the magnetite. The treatment of this non-magnetic residue for the separation of its contained gold would, in my opinion, on account of the difficulty of direct amalgamation of this sea-beach gold, be best accomplished by grinding it in a ball or pebble-mill until the gold was sufficiently scoured to cause it to amalgamate readily, and then put it over amalgamation plates.

The non-amalgamating qualities of the beach-gold may be due to a coating of oil. Some years ago an engineer who had been investigating the beach-sand mining in Humboldt and Del Norte counties of California informed me that the reason for the difficulty of amalgamating the gold in those deposits was because of the particles of gold being coated with a minute quantity of oil, derived by exudation from the underlying formations.

As regards the origin of the gold, my observations lead me to disagree with Mr. Lang. I believe that it did not originate in the ordinary quartz veins. The flatness of the particles and their extreme thinness is no evidence of an unusual origin. The flakiness is due to the abrasion to which the gold has been subjected during and after its erosion. A fact not generally appreciated is the glaciation to which the mountainous region to the eastward has been subjected, and it is to the sliding movement of the ice that the gold owes its present physical condition. Small particles of gold when caught between the ice and the rock-surface, would be flattened almost to extinction. Flakes of similar character would also be abraded from the larger particles of gold. This finely divided and flaky gold was peculiarly susceptible to transportation by flowing water. When the ice was rapidly disappearing and vast quantities of water were being given off, the glacial gravel was subjected to sorting and re-sorting action, and the thin flaky gold, on account of its large superficial area in proportion to its bulk, was largely carried to the ocean, where it has since been concentrated in the black sand.

In the heavily glaciated regions of Alaska this extremely thin flat gold is widely distributed. While it has no economic importance, it furnishes criteria for determining the origin of gold of similar physical characteristics in other regions.

JACOB W. YOUNG.

Valdez, Alaska, December 29.

MOLYBDENITE is produced principally in Australia at present, though the outlook for a substantial production in the United States is promising. Norway produced 72 tons of molybdenite in 1914, and 87 tons in 1915. Australia yielded twice this amount. A large mass of granite containing small scales of molybdenite, ranging from 1 to 10%, has recently been discovered near the California-Oregon State line, not far from Oak Bar, in Siskiyou county, California. Molybdenite is found also in El Dorado county, California, at Grizzly Flat, and near Fairplay, in granite; in quartz, at the Kings River copper mine, in Fresno county; in the White mountains, in Inyo county, at several places in Kern county, and is abundant in some of the mines near Nevada City, and at many other places in the State, as well as in Nevada, and elsewhere. The mineral recently has attracted much attention and doubtless further search and development will result in the establishment of a new industry in the West.

THE Straits tin shipments direct to the United States have increased largely during the past three years. In 1913 the total tin shipment to the United States had a value of $13,295,674, which in 1915 had increased to $17,991,042. It is expected that the annual production of Straits tin will approximate 15,000 tons for several years to come. Tin production there is always directly, and sometimes seriously, affected by labor conditions. The present price of the metal is $860 per ton. In November, 1915, the price was $825, the highest price reached in that year.

GOLD imported (net amounts) into India during the last five years was as follows: 1916, £7,000,000; 1915, £4,017,600; 1914, £8,386,000; 1913, £18,547,600; and 1912, £27,592,900.

Metallurgical Problems of the Rand

By H. Foster Bain

Introduction. Metallurgical practice on the Rand has been described with generous wealth of detail by the men responsible for its success. Indeed Rand practice has been discussed with unusual fullness and precision in two notable volumes,[1] supplemented by numerous papers read before the technical societies; particularly a recent summary by F. L. Bosqui[2] which, with the succeeding discussion[3] by C. W. Merrill, Hennen Jennings, W. A. Caldecott, A. J. Clark, G. H. Stanley, W. R. Dowling, and H. A. White, brings the whole matter up-to-date. It may not be wholly useless, however, to set down some of the questions that come up to a visitor as he makes the round of the mills under the courteous guidance of resident metallurgists.

Most readers of Mining and Scientific Press have not visited the Rand and probably never will. To them, there may be interest in learning how the Rand mills impress a visitor who comes to them with only that general knowledge of milling that the practitioner in another branch of the mining profession can claim. Preliminary to this the briefest possible summary may be presented of standard practice. In this I shall follow the excellent and brief summary contributed by W. A. Caldecott to the recent edition of Rose's 'Metallurgy of Gold.'[4]

After passing through either jaw or gyratory crushers, set underground to crush at 6-9 inches and at the surface to reduce to 1½-2 inches, the ore is fed under heavy stamps and thence through screens having openings up to ½ inch. From here it gravitates or is pumped to tube-mills, 5½ by 22 ft., passing through a cone, diaphragm or plain, the overflow being further split into sand and slime for the cyanide plant. The coarse material, with about 39% moisture, is crushed by means of selected hard pebbles (picked out of the conglomerate constituting the ore) passed over amalgamating plates, and returned to the first cone from which that which is sufficiently fine overflows, and, after passing classifying cones, goes to the cyanide annex. The sand is collected wet or dewatered on a sand-table and then mixed with solution, to be treated by percolation in vats. The slime is delivered to vats, where the mill-water is decanted, then cyanide solution is added and the material circulated by being pumped from vat to vat as the requisite number of washes are given. In a large number of plants this method has been superseded by the Butters system of vacuum-filtration, too well known to require further comment here. The solution is decanted or filtered, clarified in sand-vats, and precipitated upon zinc, mainly in the form of shaving. The general results of this treatment are summarized below, the table showing averages *pro rata* to tonnage, from the records at the Simmer & Jack, Robinson Deep, Knights Deep, and Simmer Deep mines in 1913.

Ore crushed monthly, in tons	70,567
Percentage of *minus* 90-mesh product in the tailing leaving the crushing plant	75.4
Percentage of sand, by weight	54.52
" " slime "	45.48
Screen assay-value, in dwt. per short ton	4.720
Assay-value before cyaniding, sand, dwt. per ton	2.595
" " " " slime, "	1.482
" " " " total, "	2.089
" " after " sand, "	0.354
" " " " slime, "	0.171
" " " " total, "	0.271
Percentage of theoretical extraction	94.26
" " " " by amalgamation	55.74
" " " " " cyanidation	38.52
" " actual recovery, on screen assay-value	95.17
Total working cost per ton crushed from headgear to dump	80c.

Scale of Operations. Probably the first impression received by the visitor is made by the great scale of operations and the extent of territory involved. From end to end of the Rand is 70 miles, and for almost the whole distance mine crowds upon mine. It is only in the Far East, where the lode lies nearly flat, that the distance between shafts becomes impressive. Along the Central Rand there is one nearly continuous range of tailing-piles. That this impression is not incorrect is indicated by the fact that the number of tons hoisted by the mines of the Rand in 1915 amounted to 31,331,316. This is almost exactly the total of the tonnage of gold, silver, lead, zinc, and copper ores mined in 1914 in the States of Arizona, California, Colorado, Montana, Nevada, and Utah together.

It is true that 1914 was not a good year for American metal mines; nevertheless to mine and treat in one district a tonnage comparable in quantity to that produced in six of America's most important non-ferrous metal-producing States is a job that claims respect.

The scale, too, of operations at the individual plants is large as contrasted with ordinary mining. While there is nothing on the Rand that competes with the open-cut mining of iron and copper, or that equals the 3,898,100 tons treated by the Anaconda Copper Co. in 1914, or what the Inspiration is now achieving, the Rand is a district of big mining units. The four largest producers now are the Crown, Randfontein Central, East Rand

[1] 'A Text-Book of Rand Metallurgical Practice,' by Ralph Stokes, J. E. Thomas, G. O. Smart, W. R. Dowling, H. A. White, E. H. Johnson, W. A. Caldecott, A. McA. Johnson, and C. O. Schmitt, London, 1912.

[2] Bull. A. I. M. E., May 1915.

[3] Bull., Dec. 1915 and Jan. 1916.

[4] London, 1915, pp. 400-409.

Proprietary, and Knights Deep. How the tonnage hoisted at these mines ranks with that of a few large American properties is indicated below, all figures being for the year 1915:

Mine	Tons
Randfontein Central	2,642,357
Crown	2,558,203
East Rand Proprietary	2,006,841
Knights Deep	1,143,370
Ray	2,848,969
Calumet & Hecla	3,188,583
Treadwell group	1,652,307
Homestake	1,573,822

Each mine is operated by underground methods. Such comparisons can never be pushed far, since there is always a question as to what is a mine and what a group of mines. If only the largest of the East Rand Proprietary mines were taken into account that company would rank much lower, and if the whole of the Calumet & Hecla output from subsidiaries were added that company would perhaps head the list. The latter is now mining from 17 shafts on three lodes and producing up to 11,000 tons per day from stopes extending to 5000 ft. in depth. The new mines at Juneau, Alaska, are being opened on the basis of producing 6000 to 12,000 tons per day and the Inspiration Copper company in Arizona is already hoisting 17,000 to 19,000 tons per day from one mine. The majority of Rand mines are content with outputs of less than 75,000 tons per month. It remains true none the less that the large mines of the Rand are really big mines and that the operations generally are on a much grander scale than those to which gold miners are elsewhere accustomed. In 1915, 53 companies mined 31,331,316 tons, and after 9.62% had been sorted out, 28,314,579 tons was turned over to the metallurgists for treatment. Of the 53 companies operating, 33 had in service 100 or more stamps.

Grade of Ore. The second impression is, that, as matters go elsewhere in the world, the grade of the ore is fair rather than particularly low. The average for the companies reporting in 1915 was 6.18 dwt. per ton. The number of companies working upon ore of various grades is indicated below:

Dwt. per ton	Number of mines	Dwt. per ton	Number of mines
— 4	4	7— 8	3
4— 5	10	8— 9	5
5— 6	17	9—10	3
6— 7	10	+10	1

The lowest yield was that of the Glencairn Main Reef, 3.27 dwt., and the highest the Meyer & Charlton, 10.85 dwt. Both are relatively small producers, milling 251,640, and 176,410 tons respectively. The average grade and tonnage at the four largest mines in 1915 was as below:

Mine	Tons milled	Dwt. per ton
Crown	2,497,000	6.11
Randfontein	2,446,520	5.52
East Rand Proprietary	1,983,600	6.19
Knights Deep	1,217,950	3.61

How these figures compare with a few large producers elsewhere is indicated below:

Mine	Grade
Homestake	$4.09
Alaska Treadwell	2.41
Alaska Mexican	2.62
Alaska United	2.07
Mother Lode, California	5.48
Dome, Ontario	4.80
Alaska Juneau	2.00
Alaska Gastineau	1.25
Lake Superior copper mines	2.50

The dollar is worth a trifle less than a pennyweight, but the comparison is sufficiently close for such general purposes as such figures serve. In the case of the Rand mines the figures represent the yield per ton, as is also true of the Lake Superior copper mines. The others represent the gross value per ton milled except as stated. So far as the value of the ore is concerned the Rand can hardly claim pre-eminence as a low-grade district.

Character of Ore. A third impression is made by the relative simplicity of the ore. There is no problem of refractory ores such as metallurgists elsewhere have so commonly to overcome; along the whole of the Rand there is no smelter—that last resort of the metallurgist who has to treat sulphides, arsenides, tellurides, antimonides, or other mixtures that refuse to give up their gold to mercury or cyanide. The gold in the banket can be saved by the methods in use, amalgamation and cyanidation. The limit of recovery is an economic one; it is determined by the cost of crushing and after-treatment. If I may discriminate, I should say that the local technology is simple, it is the introduction and realization of economies that demand thought and command the admiration of the visitor.

In his introductory chapter to 'Rand Metallurgical Practice,' Stokes has given the following as representative of surface costs on the Rand:

	s.	d.	Cents
Sorting out waste		3	or 6
Preliminary breaking		3	6
Transport of ore and waste		2	4
Stamp-milling	1	6	36
Tube-milling		7	14
Cyaniding, including filling, conveying, and discharging sand (65% of pulp)	1	2	28
Slime (35% of pulp)		6	12
Total	4	5	$1.06

These figures do not include general and head-office expenses, which are stated separately and amount to 1s. 6d. or 36c. per ton. Caldecott gives the following as the average cost of treating 3,387,000 tons of ore by four companies controlled by the Consolidated Gold Fields company in 1913:

	Pence per ton
Transport of ore	2.773
Breaking and sorting	3.258
Stamp-milling	10.512
Tube-milling	8.340
Sand-treatment	9.113
Slime-treatment	5.988
Total	($0.80) 3s. 3.984d.

While comparisons, from one district to another, are

of questionable value, because of difference in conditions and in methods of stating results, the following costs of treatment at mines in other countries may be cited. In each case the mines yield gold ores and the process is either one of amalgamation followed by cyanidation or by concentration with some form of after-treatment. Except as indicated, the costs are quoted from 'Mining Costs of the World' by E. N. Skinner and H. R. Plate.

The Homestake mine in South Dakota in 1915 treated 1,573,822 tons of ore by amalgamation and cyanidation, employing 1020 stamps. The company publishes its costs in unusual form and in order to get at milling costs per ton it is necessary to work back from tonnage and total charges. On this basis the total cost amounts to about 44.3 cents per ton, the items[5] being as below:

	Cents
Milling	24.25
Re-grinding	0.81
Sand treatment, leaching (in tanks)	10.81
Slime leaching (in filter-presses)	8.42
	44.29

These figures represent costs per ton milled. In a careful review of Homestake metallurgy[6] Allen J. Clark gives the following as the cost of each stage of the process, based on the tonnage treated at that stage:

	Cents
Stamp-milling	24.25
Re-grinding	12.64
Sand-treatment	17.72
Slime-treatment	18.38

The summation of these is not the cost per ton, for which figure the 44.3 cents already derived is more nearly correct. If a complete distribution of general expense were made, the total would be slightly increased. At the Homestake white men only are employed and, as on the Rand, all the material passing the amalgamation plates is cyanided.

The Treadwell group includes four mines, dropping 960 stamps in all. Only white labor is employed. Amalgamation is followed by concentration and cyanidation of the concentrate. According to the report of P. R. Bradley for 1915, the total cost of treatment ranged from 37.58 to 41.39 cents per ton. The details for the properties were as below, stated in cents per ton:

	Alaska Mexican	Alaska Treadwell	Ready Bullion	700-Ft. Claim
Milling	30.56	31.22	29.32	27.35
Concentrate treatment	9.81	9.34	9.37	9.49
Bullion charge	0.69	0.83	0.87	0.74
Total	41.06	41.39	39.56	37.58

The Mother Lode mines of California are working at various depths down to 4000 ft. and treating the ore by amalgamation followed usually by concentration, the concentrate being in turn subjected to cyanidation, chlorination, or smelting. The units of production are small as compared with the Rand. All the labor is white According to figures compiled by Charles Janin[7] the

[5]M. & S. P., April 1, 1916, p. 495.
[6]Bull. A. I. M. E., July 1915.
[7]M. & S. P., October 26, 1912.

A TAILING-WHEEL

CYANIDE VATS

FERRO-CONCRETE FOUNDATIONS

milling cost ranges from 24 to 55 cents at seven of the better known properties though higher in the case of two others mentioned. At the most progressive mine, the Plymouth Consolidated, the cost of milling is 32 cents.

Turning from the districts in which all the labor is white, I may cite the cost incurred by the Indian and Korean mines, in which natives work under white supervision. Representative Indian costs are as below:

	Milling		Cyaniding		Total	
	s.	d.	s.	d.	s.	d.
Mysore, 1912	2	2.76	1	2.16	3	4.92
Ooregum, 1912	2	1.80	1	9.24	3	11.04
Nundydroog, 1912	1	10.44	1	3.60	3	2.04
Champion Reef, 1911	2	5.88	1	8.76	3	14.64

These totals range from 76 to 94 cents per ton.

The Korean sets of costs are as below, the figures being in cents (American) per short ton:

Mine	Milling	Transport to mill	Concentrate expense	Total
Oriental Con.	47	..	19	66
Seoul Mining Co.	62	5	24	91

Consideration of these figures leads to the surprising conclusion, in which probably too much confidence ought not be placed, that even in milling, where machinery counts for so much and labor is relatively unimportant, it is only in the countries where native labor is employed that treatment costs are generally as high as on the Rand for ore that requires somewhat similar treatment and when the quantity handled per unit is of approximately the same order. It may be well to repeat that such comparisons are not to be pushed too far and instances of higher milling costs in 'all white' countries may be cited, such as the Dome in Canada, where in 1913 the total ran to $1.65;[8] Waihi in New Zealand, which had a milling and cyaniding cost of 5s. 11d. in 1912; and the Goldfield Con. in Nevada, where in 1915 the total for stamp-milling, concentrate treatment, marketing concentrate, and bullion came to $1.42 [of which 29c. was for cyanide and 39c. for water]. Probably all that one can fairly say is that Rand milling costs, while creditable, do not seem to have been lowered particularly by the presence of native labor and are not remarkable in view of the heavy investment in plant. This may be necessary and unavoidable, having in view the nature of the ore and the conditions under which the work is done, but it comes to the visitor as a bit of a disappointment. It may be helpful to try and diagnose the cause.

The Cost of Treatment depends upon (1) the nature of the ore; (2) character and cost of labor; (3) cost of supplies; (4) cost of power; (5) scale of operations.

It is clear that the character of the ore determines the treatment. The choice of method and of machine is limited by it. I have already indicated that the ore is simple in composition and does not require complex methods. The gold is 'free' if only the containing rock and pyrite be broken, so as to expose it to mercury or cyanide. The main difficulty is to so break it. In the table of costs of the Consolidated Gold Fields properties already given, it may be noted that breaking and sorting, stamp-milling, and tube-milling together account for nearly 60% of the total. Since the Gold Fields costs are among the lowest on the Rand, and since at these properties sorting has been reduced to a minimum, it may be taken the hardness of the ore is the cause of the great expense in milling. In hand-specimens the banket shows as a dense dark mass set with glistening quartz pebbles between which is a silicious matrix containing a minor proportion of pyrite. The whole is so thoroughly cemented that it is extremely rare to find the rock breaking around a pebble, and in examining large heaps of spent 'pebbles' from the tube-mills I have not seen one that showed material difference between the wear of the quartz pebbles proper and that of their matrix. The banket is 'frozen' tight to the quartzite that lies above and sometimes is interbedded with it, and the whole has become one thoroughly cemented mass. In view of these conditions the Rand metallurgist has rightly concentrated his attention upon crushing machinery, and by adding the tube-mill to the stamp he has achieved success. The average duty in tons per 24 hours for the 9396 stamps at work in 1915 was 9.53 tons. Details for a few Rand properties are cited below:

Mine	Stamps	Tube-mills	Duty per stamp
Con. Langlaagte	98	10	22.78
Van Ryn Deep	80	8	21.44
Modderfontein Deep	60	6	21.36
Government Areas	98	10	20.88
Roodeport Un.	75	4	17.05
Modderfontein B.	96	5	15.26
Geduld	60	5	14.88
Brakpan	145	10	14.84
City Deep	153	9	14.33
Simmer Deep	193	9	13.76

Despite these excellent results, and because of the high proportion of cost chargeable to crushing, there is no subject that attracts more attention on the Rand than the possibility of improving this branch of the practice. The gold occurs in the matrix partly in the quartz and partly in the pyrite. It is native and the ideal method of crushing would seem to be to crack the gangue away from the metal. This, it will be recalled, is the problem in the Michigan copper mills, where the steam-stamp has obtained such a dominant position. The thought of applying steam-stamps is not new and a series of 500-ton single units sounds attractive. When, years ago, attempts were made to domesticate the steam-stamp at the Homestake preparatory to introducing it generally in gold-milling, it was rejected largely on the basis of the increased amount of slime produced. That would now be an advantage, and the question arises as to whether there is not now scope for such stamps. The subject has been so well discussed by T. T. Read,[9] and Algernon Del Mar[10] in two papers easily available that I shall not repeat details. It is sufficient to say that conditions, in particular the presence of relatively large particles of metal held much less firmly in its matrix than the gold of the Rand banket, have been responsible for the wide vogue of

[8]Now 77c. on 40,000 tons monthly.

[9]M. & S. P., February 25, 1915.

[10]*Ibid*, October 3, 1914, p. 513.

steam-stamps in Michigan. As steam-users they are not economical save when supplementary devices have been introduced such as compounding or low-pressure turbines following the stamp. While upon the Rand the waste-steam would find a use in heating solutions to facilitate precipitation by decreasing the viscosity, the best local opinion is to the effect that progress will hardly be in the direction of such an innovation. This is all the more interesting in view of the great improvement resulting from the increased weight of the ordinary stamp[11] and the introduction of the Nissen. H. C. Behr has a project for meeting the difficulty by introducing a pneumatic stamp, in which the air, used at high pressure, is only partly expanded and then returned to the compressor. In theory such a stamp shows marked power economies but it has not yet been tested in practice.

Ball-Mills. The alternative for stamps is some form of rolls, edge-runners, or ball-mills, and many of these have been tried. So far all have proved to consume so much steel as to off-set what other advantages they show. This is imputed by Caldecott to the fact that all of them introduce abrasion, which is interesting, since about two-thirds of the crushing on the Rand is now done in tube-mills, where abrasion is most important. The figures already quoted demonstrate that the crushing done in the tube-mill costs less than that accomplished by the stamp, a fact fully appreciated on the Rand, where the tendency is to throw more and more of the work on the tubes. The explanation of the paradox is the fact that the 'pebbles' in the tube-mills are merely roughly rounded pieces of ordinary banket. Their abrasion is therefore a benefit rather than the reverse. If the work now done were accomplished by means of steel, or even barren chert pebbles, the economic ratio would be seriously disturbed.

In Canada and the United States the ball-mill has been gaining ground recently at the expense of stamps. The reason for the renewed interest lies in improved methods of discharge, as in the Marcy mill, coupled with the sizing action of the conical shape in the case of the Hardinge. At a number of mines where competitive tests have been made, ball-mills have been substituted for stamps both on the basis of economy of floor-space and of lower power consumption. At the Dome, where C. W. Dowsett, formerly at the Brakpan, is mill-superintendent, Hardinge ball-mills are being substituted for stamps to crush 3 in. material to ¼ in., with 50% passing 100-mesh. For this purpose an 8-ft. mill, 30 in. long, driven by a 125-hp. motor, is used. C. D. Kaeding, the general manager, states that the steel consumption from balls is 0.22 lb. per ton and he estimates the liner consumption at 0.60 lb. At the McIntyre a 6-ft. mill showed a total steel consumption of 1.03 lb. per ton. This may be compared with half a pound per ton with stamps on the Rand.[12] In this connection it may be mentioned that extensive trials completed some time ago on the Rand with the Giesecke, a double-chambered tube-mill, showed a quite prohibitive consumption of steel balls. As the ore in the

[11]Caldecott, W. A., 'The Development of Heavy Gravitation Stamps,' Trans. I. M. & M., 1909-1910.

[12]'Rand Metallurgical Practice,' Vol. I, p. 55.

ROBINSON CENTRAL DEEP

SAND DISTRIBUTOR

STAMP-MILL FOUNDATIONS

Porcupine district is a comparatively soft though tough schist, the Dome metallurgists are not willing to commit themselves as to what a ball-mill would do there. In this connection a word of caution may be appended as to the results of short-time tests. As balls are usually made, by forging,[13] they are much harder on the exterior than through the whole ball. A new charge therefore gives better results as to steel consumption than a true average.[14]

Another machine which is attracting attention for intermediate work is the disc-crusher. This has the advantage of great freedom of discharge, since the ore is fed through the centre and the material passes out around the circumference of a circle, the action being rendered positive by employment of centrifugal force. It also has the advantage, which may prove important on the Rand, that the crushing is not accomplished by rolling or abrading, but by pinching or nipping. The action is similar to that in a jaw-crusher since the two horizontal revolving discs are set slightly eccentric to each other so that the two rims approach and recede as do the jaws of an ordinary crusher. One of the disc-machines has been used in crushing waste-rock on the Rand for road-making. Last spring the Mines Trials Committee began a series of tests upon it to determine its availability for regular work in the mills. The preliminary figures showed remarkable results as regards quantity of material handled and power consumption, but the excessive consumption of steel was found to offset all other advantages, and the disc-crusher was condemned as wholly inapplicable to Rand ore.

Amalgamation. If the hardness of the ore is a serious detriment to low crushing-costs, the fact that the gold is 'free' simplifies the succeeding treatment. Despite various changes, amalgamation still plays an important part in the recovery of the gold, although the use of coarse screens in front of the stamps has necessitated the transfer of the plates to a position below the tube-mills. At the Homestake mill, Clark has shown[15] that from 86 to 91% of the amalgamation is accomplished in the mortars and on the first two rows of plates, and it is common experience that the bulk of the gold is saved near the head of a string of plates. On the Rand amalgamation in the mortars has long been abandoned and the plate-area greatly restricted. It was, I believe, Mr. Maxwell at the Randfontein who first made a radical reduction in plate-area, but the practice has now become general, the minimum being in the Gold Fields mills, where there are only three plates of 4½ by 12 ft. area per tube-mill circuit. It has been found that the consumption of mercury is proportionate to the plate-area exposed, but the recovery of gold is not. With the efficient cyanidation plants now in use there has been no increase in tailing-losses in consequence of reducing the plate-area. Of the total value recovered in 1915, namely, £37,264,992, amalgamation was responsible for £23,809,801, or 64%. Contrary therefore to the general impression, amalgamation is still much more important than cyanidation on the Rand. It is a bit surprising to contrast the small area devoted to plates and the big yield from it, with the acres of vats and other plant devoted to cyanidation. It is easy to see why local metallurgists hesitate to adopt any method that interferes with amalgamation; all the more in view of the fact that while the bulk of the gold exists in the rock in very fine particles, coarse gold is present and often in amounts sufficient to threaten serious tailing losses if the present system of cyanidation alone were relied upon.

Crushing in Cyanide. It is this that has stood in the way of crushing in cyanide, despite the great saving that might be realized if the process were adopted. The objections are mainly the corrosion of the plates and the difficulty in sampling. Minor objections are the necessity for handling a baser bullion due to the cyanide dissolving copper from the plates, the need of a more expensive cyanide treatment, and the increased liability to loss from leakage. It is just possible that these difficulties are not so serious as has been thought. It was in 1892, I believe, that the process was tried at the May Consolidated and condemned, and much has been learned since that pioneer date. It has been my general observation that in mills where crushing in cyanide is practised the trouble with the plates is much less important than had been anticipated. At the Lonely Reef only a few months ago I was told that there was no trouble. While, owing to the small plate-area used on the Rand, amalgamation practice differs a little from that in other districts, it is still not easy to see why there should be any corrosion beyond the control of capable metallurgists. Remembering the years that shaking plates were built on the Rand because of some early experiments, only to be found later unnecessary and abandoned, and recalling various metallurgical experiences in other districts, the visitor wonders whether by chance this is another instance where a thing is believed to be impossible because it has not been recently tried.

Sampling. The cost of this can be overcome if it be considered worth while. It is true that reliance upon lip-samples, as at present, would not be safe, but even now lip-samples taken at intervals of six hours seem woefully inadequate, despite most convincing tabulations and records. The miner makes up his figures by combining stope-samples. The mill-man depends upon lip-samples taken at the mortars. The two do not check and there is the same feud between mine and mill on the Rand as in other districts. Even lip-samples taken in different sets in the same mill do not altogether check and it is only the blessed law of averages that saves the situation. If it be judged of sufficient importance it would not be difficult as a technical matter to take a complete sample ahead of the stamps where at most Rand mills the whole stream of ore is re-united after passing through the ore-house. At the point where the main belt delivers to the movable cross-belt, which in turn delivers to the ore-bins, an automatic sample of any desired size

[13]Now mostly cast-steel. However, the comment holds good.

[14]For general discussion see articles in M. & S. P. by H. C. Cutler, February 5, and Henry Hanson, March 13, 1916.

[15]*Op. Cit.*, p. 1385.

could be diverted and, after being mechanically quartered down, returned to the stamps. Especially in mills where plates have been taken out of old structures there is room that could be used for a sampling-plant, and in any new mill proper space could easily be secured. The methods of mechanical sampling and weighing are so well understood that it is hardly necessary to quote details. At the Washoe mill of the Anaconda company a larger tonnage than that treated by any Rand company is handled and the ore has long been regularly sampled in a plant built by D. W. Brunton. At normal prices for metals the gross value of the ore at Anaconda is less than at a considerable number of Rand mines, including such properties as the City Deep and Ferreira Deep. The ore comes to the mill at Anaconda in a condition as regards coarseness, irregular moisture content, and other features not greatly different from the Rand ore as usually delivered. Mechanical sampling is feasible if it be considered worth while. It must be admitted, however, that with the later development of Rand milling, where the pulp travels in a series of impinging circuits with its escape from one to the other controlled by the accuracy of exceptionally good classification, there is some justification for the dictum of Rand metallurgists that it is far less important to know what gets into the mill than what leaves. A reasonably accurate method of sampling the feed may be accepted so that more time and attention may be devoted to greater accuracy in determining the product and the tailing.

Whether crushing in cyanide would unduly increase the expense of cyanidation itself, or, with proper safeguards, seriously add to losses from misdirected solutions, I make no attempt to determine. Possibly further study on these points would reveal methods of meeting the situation.

Concentration. At various times proposals have been made for supplementary amalgamation by concentration and before the cyanide process attained ascendancy large sums were spent on tables, vanners, and other concentration devices. This has all been given up. The plan breaks down before the simple fact that the gold occurs not only in the pyrite but in the quartz. If therefore all the sulphides in the ore were concentrated successfully there would still be a heavy loss of gold in the uncrushed particles of quartz. When the material is crushed sufficiently fine to release the gold in the quartz it is also released from the pyrite and open to attack by either mercury or cyanide. By a fortunate circumstance the arrangement of dewatering and sizing cones in the tube-mill circuit is such that the particles of pyrite are subjected to more crushing and longer treatment than the quartz, so that there is added opportunity for release of the gold.

The objections to ordinary wet concentration would apply equally in the case of flotation, and would even be stronger, since the air-bubbles are not known to have any affinity for gold. At the Falcon mines, where flotation is used, the greatest care is exercised to save the coarse particles of free gold before the pulp goes to the flotation-cells, and this would be necessary on the Rand as well. So far as present knowledge goes there seems little reason to expect that it will prove feasible to use flotation as a supplement to amalgamation alone and so to substitute a simple compact plant for the acres now devoted to cyanidation. If flotation be introduced it seems best to use it as a supplementary process for treating the sand or slime after cyanidation. According to J. E. Thomas,[16] the pyrite, while constituting but a small percentage of the residue, contains from 6 to 10 times as much gold. It is worth investigating whether it would not be possible by flotation to produce a small amount of relatively rich material here, operating with a high concentration ratio. This is all the more possible since in South Africa the sulphur as well as the gold in any such concentrate would probably be of value. It is said that in the Black Reef there are considerable bodies of low-grade pyritic ore. Formerly attempts were made to work them by wet concentration, though with no great profit, according to report. Some work is being done now. It is possible that here also is a field for flotation.

In the work of cyanidation as practised on the Rand, among the striking characteristics are (*a*) the large use made of centrifugal pumps; (*b*) the perfection of the sizing and classification; (*c*) the persistent use of decantation; (*d*) the employment of zinc-shavings for precipitation; (*e*) the growing use of vacuum-filters for slime-treatment.

Tailing wheels are giving place all along the Rand to centrifugal pumps, which are being used for elevating materials from the finest slime up to ½-inch stuff. The pumps cost less, and while operating charges are higher, they have the great advantage over wheels that changes in plan requiring a higher lift do not necessitate scrapping the whole plant. The wear on impellers and liners is naturally heavy with coarse material, and so far no quite satisfactory system of reinforcement has been devised. At the Geduld hard iron liners last about 26 days. Probably this need will be met in time by building small foundries at the mines and re-casting scrap. This is done with good results in Rhodesia. At the Lonely Reef only one skilled white man is employed on the work, but melts are made twice a week and many shapes, including pump-parts, are cast. The cost is 4 to 5c. per pound and the scrap is used over and over. A similar system of relying on cheap material frequently re-cast has been found applicable at Joplin, Missouri, and in many districts where better material of longer life would be, as on the Rand, unusually expensive.

The work of dewatering and classification is conducted on the Rand on a big scale and with excellent results. Cones, especially the delightfully simple and effective diaphragm-cone invented by Caldecott, are much used. These are often supplemented by the sand-table, which was also designed by him and which proves most satisfactory in operation. These features of Rand practice have been so well described that I need merely mention them.

[16] 'Rand Metallurgical Practice,' Vol. I., p. 181-182.

Decantation is another process that has achieved unusual prominence on the Rand. To the visitor it is one of the most impressive features of local practice. To settle slime to a 40% moisture content, in great quantity and within the time limits that may be allowed in practice, is an achievement indeed, and however much one may go to the Rand prejudiced against a discontinuous process of this type, he is bound to return with the feeling that there is much to be said in its favor. In other regions the whole trend is toward continuous processes made as automatic as possible, and it may be noted that in the plans for the new Modderfontein mill the slime treatment will be along this line, with Dorr thickeners such as are used so generally in Canada, the United States, and Mexico. In this connection it may be pointed out that even in a country of low-priced labor, metallurgical results and costs seem to gain by substituting machinery for men where possible. The mills on the Rand that treat the lowest grade of ore, and at the most favorable cost, are the very ones where the fewest men are seen.

Supplementing decantation by vacuum filtration is now recognized as standard practice for new plants. Filters have been added to a number of old ones. While the additional recovery has not shown as high a profit as was anticipated, there is still sufficient profit to justify the added investment. It should be remembered that a final tailing worth only 0.25 dwt.—and that is what Rand metallurgists work toward—does not leave much margin. An actual recovery of 95 to 96% on ore of the grade treated on the Rand must be conceded to be satisfactory.

Precipitation is still done by means of zinc-shaving. The pros and cons of zinc-dust precipitation, which has so generally replaced zinc-boxes elsewhere, have been stated in detail by Bosqui. It may be pointed out that the choice of method on the Rand is not wholly governed by technical conditions, though the weakness of the solutions is a factor. So long as it is a settled policy to show the same clean-up per month without very close regard to the grade of the ore milled, it is a matter of great convenience to have in the hundreds of zinc-boxes a reservoir that may be used as a regulator.

Cost of Supplies. The Rand, owing to its distance from manufacturing centres, is a district in which cost of supplies is unavoidably high. The total amount expended in the Transvaal in 1915 for such supplies as are listed by the Government Mining Engineer was £10.889,-115. This may be compared with the total of white and native wages and salaries, namely, £13,501,291. It is difficult to segregate the mill-supplies. Caldecott gives the following as the average consumption of metallurgical stores per ton of ore milled by the Consolidated Gold Fields companies in 1913.

	Pounds
Mercury	0.0664
Lime, 75%	2.1822
Sodium cyanide (130%)	0.3072
Zinc	0.3965
Lead acetate	0.0487
Bisulphate of soda	1.4805

The total amount expended on the Rand in the same year for purchase of the chief mill-supplies is listed below:

Cyanide	£538,366
Zinc	234,330
Lime	124,850
Shoes and dies	159,552
Tube-mill pebbles, liners, etc.	56,361
Mercury	34,435

These few figures sufficiently emphasize the importance of careful buying and, back of that, of systematic and thorough study of the quality, uses, and possible substitutes for each material bought. Since the War began, great progress has been made in this direction, and various inter-mine committees are now at work looking for substitutes or methods of decreasing the amount used per ton. From their work important technological assistance may be expected. The Consolidated Gold Fields maintains, under the direction of A. McArthur Johnson, a testing-laboratory that is of much service in setting standards for supplies.

Cost of Power. Most of the mines now buy power through the Victoria Falls Power Co., which maintains steam-generating stations, transmission mines, and pipes for distributing electricity and compressed air. Where individual power-stations are maintained at the mine there is a by-product in that the waste-steam is used to warm the solutions and so facilitate decantation. That this is not more general is due to the fact that the purchase of current is so common. South Africa is fortunate in possessing abundant coal that may be cheaply mined. This, with the excellent character and large size of the generating-stations, results in low charges for power. Contracts are made for 12 and 20 years and current is furnished at 2100 and 525 volts. The consumer supplies a sub-station building and pays an additional 2% on his bill to cover losses in transforming and stepping-down the current, but the switches, transformers, and other gear are furnished by the power company. The standard and price on a 12-year contract is 0.515d. per unit so long as the monthly load-factor is 70% or better. The price is subject to revision under certain contingencies as to cost of production, and there is a penalty of 7s. per hour per 100 kw. for failure to supply current. Actually there are remarkably few stoppages, since the power company draws from several stations and has a network of transmission lines. The largest station is at Vereeniging, where the Vaal river furnishes abundant water for the condensers and the New Cornelia Colliery supplies coal. The plant is equipped with mechanical stokers, water-tube boilers, and every device for labor-saving. It is, I believe, the fourth largest power-station in the world and supplies about 25,000,000 electric units per month to the system, using about 3% of its gross output to move its own machinery. About 5% is lost in transmission. The coal consumption varies from 1100 to 1300 tons per day, depending upon the proportion of total load assigned to this station, and, despite the fact that the coal is high in ash, the generating cost is the lowest of that at any of the company stations.

It is planned to increase the plant to a size that will demand 60,000 tons of coal per month. Thanks to the excellent manner in which the scheme has been carried out the company is a profitable enterprise despite the low price at which current is sold. In this particular the Rand mines are fortunate.

Labor Problems. The mills have a constant fight to keep from having an undue proportion of the least efficient men passed to them. A poor workman underground is a danger to so many aside from himself that naturally and properly the tendency is to make a place for him at the surface. Here he is often able to work effectively, but it is not a rule without exceptions. Native labor at best has many drawbacks and can hardly be expected to show high efficiency, but in its distribution the mills get the worst of it. The same is true to some extent of white labor, and many a man contrives to keep his connection with the pay-roll in a mill who would be dismissed even by a Rand shift-boss, who is usually so short-handed that he becomes extremely long-suffering. In most mining districts the pressure is for jobs at the surface and the bright young men from the schools of mines feel that there is better opportunity for them to use their technical knowledge above than below ground. On the Rand a larger part of the best technical graduates go underground for the reason that there is no other route to the coveted position of mine-manager. Attempts have been made to balance matters by creating the position of Reduction Works manager with control over both stamp-mill and cyanide annex, with a salary corresponding. So far this has not been widely done and most millmen reach the limit of promotion and pay in a few years. After that the life is not especially attractive because of the monotonous routine. A Rand mill, handling always the same ore, artificially kept as nearly as may be to a predetermined grade, does not offer much field for novelty. In certain organizations the disagreeable conditions are made worse by the line drawn between the operating man at the mine and the head-office metallurgist. The operator is not unlikely to get into the attitude of dodging responsibility. The mill is handed to him complete, he has no part in its design or erection, and if changes are made they will be determined by the head-office man. It is not unnatural, however deplorable it may be, that some of the men drift into the mental state where they reason that so long as they suggest nothing they will not be responsible for a failure and so long as they keep the other man's plant going even reasonably well, they are sure of a comfortable job. With neither increased pay nor credit to gain, why take responsibility for suggesting any change? I would not imply that all the mill-superintendents adopt or act on any such ideas, but the feeling is present on the Rand and shows in the work. The consulting metallurgists as a class are a fine type and have been wonderfully skillful in preventing the growth of this feeling among operating men, but it is not an easy task where lines are drawn so sharply between operation and design and where the rewards on the two sides of the line differ so greatly.

The isolation of the district is a great handicap. Many of the men in the mills have never seen any other metallurgy than that of the Rand. They are extremely narrow specialists and it is difficult to see how this is to be avoided. The leading men keep in touch with practice around the world, but the subordinates cannot afford to do so on their incomes and they do not have the opportunity, open in most great mining districts of quitting and going elsewhere. How much this factor of isolation affects costs it is impossible to say, but that it does do so is patent. This brings out again the old fact that regardless of the character of the ore, the cost of power, or the type of plant, the human factor enters into milling, and to its consideration many anxious hours must be devoted by the chief on whom falls the main responsibility.

The Source of Copper in Gold Bullion

Copper is nearly always present in gold bullion derived from amalgamating in mills. The source of most of this copper is the detonating caps used in blasting. The amount will vary greatly, depending on the ratio of shots fired to the tonnage of ore milled. In some mines every ton of rock broken is the direct result of one or more blasts. In other mines, the method of mining and the character of the ore, or its condition, are such that many tons can be obtained without firing a shot. In a mine that produced and milled 5000 tons of ore monthly, 1500 shots placed in ore were fired. Many other shots were in waste, but assuming that the greater part of the copper of the detonators fired in stoping mixed with the ore and went to the mill, then this copper, which was still in metallic form, amalgamated, together with the gold, and most of it entered the bullion. The copper in 500 detonators of the usual size weighs about one pound, and the 1500 caps exploded in a month then weigh three pounds avoirdupois, which is equivalent to 47.74 troy ounces. The ratio of copper to gold depends on the amount of amalgamable gold in the ore, so the proportion of copper entering the bullion may be relatively great or small. Comparatively little copper in mill-bullion is derived from the abrasion of plates, or from pieces of plate that may be broken off in the battery, or from copper screws, or other copper articles that find their way into the mortar, for these are usually seen and removed when cleaning the amalgam. Scarcely any copper comes from the ore. The lead so often found in the gold-sponge taken from the retort can generally be traced to pieces of babbitt that fall from the cam-shaft boxes, or from the spindle of the rock-crusher.

India is a large producer of both manganese and tungsten ore. The output of manganese ore in 1915 was over $4,500,000 and of tungsten, $1,444,000.

Aluminum money was issued by the Chamber of Commerce of Marseilles, France, during 1916. An issue was also authorized by the German Government.

The Minerals Separation Campaign

Herewith we publish, for what interest they may offer to our readers, the letter sent by the Minerals Separation company to those not licensed by it and the list of questions that the latter are requested, or commanded, to answer.

January 22, 1917.

The Blank Mine,
Blankville.

Gentlemen: In behalf of my clients, Minerals Separation, Limited, of London, England, and Minerals Separation North American Corporation of 61 Broadway, New York, N. Y., you are hereby notified of infringement of my clients' patents for froth flotation concentration of ores, and particularly the basic patent for such a process, No. 835,120, issued November 6, 1906, to Sulman, Picard and Ballot, recently held to be valid and infringed by the Supreme Court of the United States in the case of Minerals Separation, Ltd., and another against Hyde. I am enclosing a copy of the opinion and order of the Supreme Court and of the decree and injunction affirmed thereby with immaterial modifications. My clients are willing to grant licenses to those who wish to use their inventions, but before any consideration can be given to that matter, a full settlement for past infringements must be made, and this altogether regardless of whether or not you wish to continue to use flotation.

You are therefore hereby directed to send to me a full statement of your infringing operations in accordance with the interrogatories enclosed herewith, in default whereof I am directed to commence suit against you for an injunction, profits and damages, including a preliminary injunction at the commencement of the suit to immediately stop your infringing operations.

Yours, etc.,

HENRY D. WILLIAMS.

STATEMENT OF FLOTATION OPERATIONS

1. Name of Company.....
2. Where incorporated .....
3. Home office address.....
4. Name of mine.....
5. Mine address .....
6(a). Is mine in operation.....
(b). Is mill in operation.....
7(a). Present daily tonnage.....
(b). Expected daily tonnage.....
8. General character of ore.....
9. Principal sulphide minerals.....
10. Principal gangue minerals.....
11. Type and daily capacity of milling plant.....
.....
12(a). Is the flotation process in use or has it been used, experimentally or otherwise, in this mill.....
(b). For how long.....
13. What products are or have been treated by flotation .....
14. What is the total mill recovery.....
15. What proportion of total recovery is due to flotation .....
16. Number of tons treated daily by flotation.....
17. Total tonnage treated by flotation to date.....
18. Total concentrates produced by flotation to date .....
19. Average assay value of flotation concentrates.....
20. Gross market value of all flotation concentrates produced to date in this mill.....
21. Type and manufacture of flotation apparatus used in this mill.....
22(a). Have any flotation tests been made on this ore...
(b). If so, by whom.....
23. On separate sheet, give complete details of flotation tests made.
24. Remarks .....
.....

Dated ..... Signed .....
Title.....

MOLDING-SAND is used in foundries, and as the name signifies is employed in molding the forms into which the molten iron is poured to make the castings. The only sand that has been found to give good results in molding is of natural origin, and consists of fine sand bonded by a small amount of clay. Numerous attempts have been made to grind silica and mix it with clay for the purpose, but this was expensive and the result was unsatisfactory, as the sand does not stand well in the molds. A microscopic examination of a good natural molding-sand shows the quartz grains to be angular, from the coarsest down to the finest that can be discerned. These angular grains do not pack as closely as rounded ones, and therefore the mass has a greater permeability to gases. These quartz grains show the characteristic fracture of silica that has been comminuted by crushing under pressure, rather than by attrition or abrasion. The molding-sand obtained in most of the Eastern States is found in the area of glacial drift, and is supposed to be of glacial origin. Some sand suitable for foundry-molds has been mined near Ione, in Amador county, California, but good sand of this description is scarce.

MINERAL OUTPUT of British Columbia during 1916 is officially valued at $42,970,555, a record and an increase of $13,523,047 compared with the previous year. Both lode and placer gold showed a decrease.

The Origin and Geo-Chemistry of Magnesite

By S. H. Dolbear

Introduction. Magnesite is usually defined as the normal carbonate of magnesia, composed, when pure, of magnesium oxide 47.6% and carbon di-oxide 52.4%. Mineralogically this definition is correct, but magnesite subjected to heat loses its carbon di-oxide, and the residual magnesium oxide is also designated as 'magnesite.' The use of the word has become too general to limit its application alone to the carbonate. Furthermore, the word 'magnesite' is not used generally in describing artificially prepared magnesium carbonate.

Vein Deposits. Magnesium forms with silica a long list of silicates. Very few of these occurring in nature are simple silicates of magnesium, for they usually contain iron, alumina, lime, and sometimes other elements in varying formulae, as for example hypersthene, diopside, and the more complex augites.

The ease with which magnesium silicates are broken down when brought in contact with carbonic acid and water has been demonstrated in the laboratory. In the case of the alteration of olivine the reaction is represented by the equation:

$$2Mg_2SiO_4 + 2H_2O + CO_2 = H_4Mg_3Si_2O_9 + MgCO_3$$

and similarly in enstatite:

$$4MgSiO_3 + H_2O + CO_2 = H_2Mg_3(SiO_3)_4 + MgCO_3$$

In each case magnesite ($MgCO_3$) is one of the products, while it will be seen that the residual materials possess chemical formulae different from one another. This residual material is represented in nature principally by serpentine but sometimes by such substances as talc, and chlorite. Lack of space prevents a discussion of the chemical influences of carbonic acid on each of the many silicates, but the cases stated above may be taken as characteristic. It is noted that water plays an important part in these reactions, the residual material usually becoming hydrous. These reactions, however, appear to be incomplete and it is logical to conclude that all of the magnesium present in the original rock—olivine, enstatite, etc.—may be converted to magnesium carbonate if the conditions resulting in the incomplete change persist. Then reaction (1) below would be followed by reaction (2), the conversion of all magnesium present to $MgCO_3$ would be accomplished, while water and silica would be set free.

(1) $4MgSiO_3 + H_2O + CO_2 = MgCO_3 + H_2Mg_3(SiO_3)_4$

(2) $H_2Mg_3(SiO_3)_4 + 3CO_2 = 3MgCO_3 + H_2O + 4SiO_2$

This would then account for the free silica in magnesite deposits and justify the supposition that deposits in rocks that are greatly altered are more likely to contain high proportions of silica than those in less altered areas.

Carbonic Acid. Several sources of carbonic acid are possible:

1. Atmospheric carbonic acid.
2. Organic—arising from oxidizing organic matter.
3. Occluded gases.
4. Deep deposits of calcium carbonate.

1. Atmospheric carbonic acid is that present in the atmosphere, which today contains normally about 3 parts by volume in 10,000. Heavy vegetation during the

VEIN OF MAGNESITE IN A CALIFORNIAN MINE.

Carbonaceous age leads us to believe that the atmosphere of that time contained a much greater proportion. While the magnesite deposits are of a later period, the fact remains that the diminution of CO_2 in the atmosphere was gradual, so that during the time magnesite was being formed this source was more important than now.

2. Organic carbonic acid need not be taken as an important factor. There is no evidence of abundant organic matter in the vicinity of magnesite deposits.

3. When heated to high temperatures in vacuum, rocks are made to yield astonishing quantities of uncombined gases, including carbonic acid. It cannot be contended that the presence of these is due to absorption, as free

hydrogen is also driven off, and the latter is not known to exist under normal conditions in the atmosphere. As the alteration of these rocks to magnesite and associated substances is dependent on the presence of water, it is not probable that these occluded gases have any immediate influence unless other agencies—such as heat—set them free.

4. Calcium carbonate as a source of CO_2 in magnesite has not been hitherto suggested, but it seems worthy of consideration. There is some evidence, of an indirect character, that relatively deep-seated limestone deposits may exist in at least some of the magnesite localities. 'Gas pockets' are not at all uncommon in magnesite mines. Sulphide minerals, such as pyrite, are found disseminated through the associated rocks. These sulphides when undergoing oxidation would acidulate descending solutions, which might themselves react on the magnesium-silicate rocks were they to reach them under favorable conditions as to heat and pressure. If, however, these acid solutions be brought in contact with the calcium carbonate of an underlying series, CO_2 would be liberated.

Masses of magnesium silicate intruding through limestone would cause a change in both. This might be represented by the formation of magnesium carbonate and a calcium silicate within the contact region.

Deposition of Magnesite. The presence of CO_2 in great excess would increase the solubility of $MgCO_3$ and this would be deposited when the solution yielded its excess CO_2 through freedom from pressure, cooling, evaporation, or because a part of the CO_2 would be required to form $MgCO_3$ with the magnesium-silicate rocks with which it would come in contact. Then we would have magnesite replacing the wall-rock of veins, and examples of this kind are quite common. It may be recognized either by the presence of serpentine 'horses' or by the gradation of magnesite into the wall-rock, usually without any distinct mark between the two.

We have then two types of deposit resulting from the alteration of magnesium silicates, the true vein deposit and that resulting from replacement. The latter would usually be irregular in form and might be designated as lenticular.

Sedimentary Deposits. Two of these have been reported in the United States; they are believed to have resulted from the contact of soluble magnesium salts with alkaline carbonates. The most common soluble magnesium compounds found in nature are the chloride and sulphate. The reaction would be represented by

$$MgSO_4 + Na_2CO_3 = MgCO_3 + Na_2SO_4 \text{ or}$$
$$MgCl_2 + Na_2CO_3 = MgCO_3 + 2NaCl$$

Sodium carbonate is quite common in the desert alkaline basins and it is in these regions that the sedimentary deposits are found. The question, therefore, is not the source of the carbonate radical, as in the case of vein-type deposits, but the source of soluble magnesium compounds.

Sufficient space is not available for an exhaustive discussion of this subject. In the Pacific Coast region there are two examples of this type of deposit, one at Bissel, near Mojave, California, and another near St. Thomas, in Nevada. Data regarding magnesian rocks that might act as a source of magnesia in the latter locality are not available. The magnesian series in the Bissel area are represented by talc, actinolite, and similar alteration products of primary basic rocks. The presence of gypsum ($CaSO_4$) and sodium sulphate in this area suggests that the magnesium salt entering into the final reaction to form magnesite was magnesium sulphate.

The sulphuric acid radical undoubtedly had its origin in decomposing pyrite, but it is not at all certain that the alteration of magnesium-silicate rocks was due directly to contact with sulphuric or sulphurous acid in the circulating ground-water. Had this been the case the decomposition would probably have been more complete and the resulting solution would have contained much iron. Analysis of the Bissel ore does not disclose a large iron content. Four analyses show

$$Al_2O_3 + Fe_2O_3: 2.46\%; 2.94\%; 1.40\%; 0.76\%.*$$

Evidence points to alteration by carbonic acid and the subsequent action of sulphuric acid on magnesium carbonate in solution to form the more soluble magnesium sulphate. This was carried to the playa in solution and here brought into contact with alkaline carbonates, also in solution, as indicated by the reaction stated above.

Another point leading to the belief that magnesium sulphate rather than magnesium chloride was the salt involved, is the relatively small quantity of lime present. The agencies producing magnesium chloride would probably also have produced calcium chloride, the solubility of which is very high. In the case of sulphates, the calcium salt would be insoluble and a separation afforded from the magnesium sulphate. Analyses for CaO reveal: 4.25%; 3.36%; 1.56%; trace.†

The recent discovery of dolomite adjacent the deposits of sedimentary magnesite at Bissell cannot be explained until further data regarding the occurrence are available. It will probably be found to have originated during a different geologic period and from a source not closely related to that of magnesite.

Deposits of sedimentary magnesite should be examined for soluble alkalines if intended for refractory use, because the presence of such alkalines in quantity would reduce the fusing-point of the material.

Hydro-Magnesite. This is a magnesite having the composition $3MgCO_3Mg(OH)_2 + 3H_2O$.

It occurs both in sedimentary and vein deposits, and in the latter is probably a secondary product formed when magnesite has been re-dissolved and re-precipitated by chemical reactions such as are described in the foregoing paragraphs on sedimentary magnesite. It is usually associated only sparingly with magnesite in veins, although at Red Mountain in Stanislaus county, at Devil's Hole in Alameda county, and in British Columbia it is found separately in quantity.

*Analyses of J. S. Fairchild, U. S. Geological Survey.
†*Ibid.*

Copper Consumers in the United States

After considerable investigation the *Boston News Bureau* has compiled the following:

	Monthly lb.	Per annum lb.
American Brass Co.	25,000,000	300,000,000
Buffalo Brass Co.	12,000,000	144,000,000
Chase Rolling Mills	12,000,000	144,000,000
National Conduit & Cable Co.	10,000,000	120,000,000
Detroit Copper & Brass Co.	8,000,000	96,000,000
Scoville Manufacturing Co.	8,000,000	96,000,000
Roebling Sons Co.	6,000,000	72,000,000
Standard Underground Cable Co.	6,000,000	72,000,000
Bridgeport Brass Co.	6,000,000	72,000,000
Rome Brass & Copper Co.	6,000,000	72,000,000
American Electrical Works & Phillips Insulating	6,000,000	72,000,000
Waclark Manufacturing Co.	4,000,000	48,000,000
Baltimore Copper Smelting & Rolling Co.	4,000,000	48,000,000
Seymour Mfg. Co.	3,500,000	42,000,000
American Steel & Wire Co.	2,500,000	30,000,000
Michigan Brass Co.	2,000,000	24,000,000
Plume & Atwood	1,500,000	18,000,000
Bristol Brass Co.	1,250,000	15,000,000
Baltimore Tube Works	1,000,000	12,000,000
Taunton-New Bedford Copper Co.	1,000,000	12,000,000
Randolph Clowse	1,000,000	12,000,000
C. G. Hussey Co.	1,000,000	12,000,000
Stamford Rolling Mills	1,000,000	12,000,000
Hendricks Brothers	750,000	9,000,000
Miscellaneous	6,500,000	78,000,000
Total	136,000,000	1,632,000,000

From an obscure position the Buffalo Brass Co. has forged rapidly ahead to a position second only to the American Brass Co. in the amount of copper used.

Eolian Concentration of Mineral Salts

Desert basins frequently afford evidence of the former existence of lakes that at one time covered large areas. Usually these 'lakes' now are entirely dry. Their distinguishing feature is a level floor of hard sandy clay. Some of them become covered with a shallow sheet of water immediately after a heavy rain, but evaporation is rapid and they resume their dry state quickly. In such dry basins the minerals that once were held in solution have been precipitated after the water became saturated with them by continued evaporation. When this has happened such minerals may now be seen forming a snow-white crust on the surface, or they are found in a succession of deposits intercalated with layers of fine sandy clay that has been carried into the lake during successive floods. The principal mineral salts thus deposited are sodium and magnesium chlorides, calcium borate, borax, sodium and magnesium carbonates, sodium and magnesium sulphates, and calcium sulphate. There are other salts—notably those of potassium—but these usually occur, if at all, in relatively small amounts and in few places. Borax, salt, and soda are the minerals of greatest commercial importance that have been obtained from such sources. There is an unusual deposition of mineral salts on the east side of the Rodriguez dry lake, on the Santa Fe railroad 20 miles south-east of Mojave, in Kern county. This lake covers nearly 60 square miles. No efflorescence of mineral salts shows on its surface, but, on what may be called its eastern shore, there is an accumulation of sodium and magnesium sulphate, with some carbonate. These salts are found in crusts or layers of coarsely crystallized mineral in little basins among the sand-dunes that line the shore for a long distance. Curiously, the sand-dunes are confined almost exclusively to this side of the lake, indicating the prevailing direction of the wind. As there is seldom any water standing, and as there is no efflorescence of minerals to be seen, the natural query is, what is the origin of the concentration of mineral salts on the east shore? A number of wells and bore-holes were sunk in the lake-bed to determine the character of the subterranean water, which was found a few feet below the surface. Analyses showed the presence of sulphates and carbonates of sodium and magnesium, but in minute quantity. The conclusion was reached that the crystallized minerals deposited in abundance among the sand-dunes must have originated from the surface of the lake, where they had formed repeatedly as a thin efflorescence, and that the minerals had been blown from the floor of the lake, when dry, upon the east shore together with the sand. There are several small springs in the vicinity—mere seepages—but these, apparently, have supplied sufficient moisture to dissolve and concentrate the salts in favorable places.

Gold From River-Bottoms

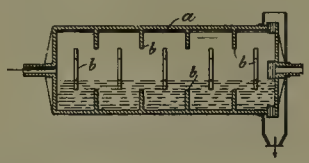
On the Ohinemuri river, 17 miles from Waihi and 8 miles from Karangahake, New Zealand, the Waihi-Paeroa Gold Extraction Co. continues to recover gold and silver from the tailing washed down that stream from the plants treating ore in the mining districts. This tailing is rather the accumulation of years than new material. It is dredged from the river-bottom, ground in tube-mills (22), cyanided by agitation in Pachuca tanks, and filtered by vacuum-filters. A recent yield was $23,500 from 16,700 tons of tailing, equal to $1.40 per ton. Since starting operation 653,700 tons has given bullion worth $936,000. Dividends amount to $60,000.

Flotation at Broken Hill

Owing to labor troubles early in 1916 the De Bavay process of the Amalgamated Zinc company operated at low capacity. In 20 weeks 91,438 tons of tailing was treated, yielding 25,669 tons of concentrate assaying 48.9% zinc, 5.8% lead, and 7.4 oz. silver; also 440 tons containing 58.6% lead, 9% zinc, and 48 oz. silver per ton. Treatment, royalty, and payment of tailing, etc., cost $5.08 per ton.

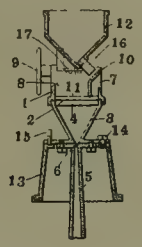
RECENT PATENTS

1,204,554. Tube-Mill. Johan S. Fasting, Frederiksberg, near Copenhagen, Denmark, assignor to F. L. Smidth & Co., New York, N. Y., a Corporation of New Jersey. Filed Apr. 28, 1915. Serial No. 24,437.



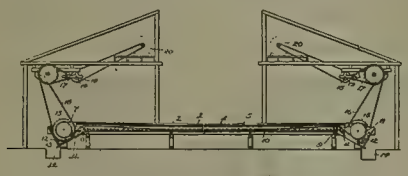
1. An improvement in the art of grinding in grinding mills which consists in producing in said mill a slowly rotating mass of grinding bodies and a material to be ground, applying closely related annularly arranged and extended frictional lifting ribs having surfaces extending in the direction of rotation to said mass while rotating and causing a free longitudinal feeding of said mass at points below the inner surface of said rotating mass.

1,202,219. Ore-Separator. Albert M. Plumb, Denver, Colo. Filed June 30, 1913. Serial No. 776,529.



1. In an ore jig, a separating chamber provided with means for maintaining at least two separate columns of material communicating at their lower ends and with discharge openings for each column, the relative heights of the discharge openings being such that the weights of the columns of material, when each extends to the level of its discharge opening, will be substantially proportional to their horizontal cross-sectional areas, means for agitating the material in the separating chamber and means whereby the material adjacent to the tailings discharge opening will be agitated to a greater degree than other portions of material in the same column.

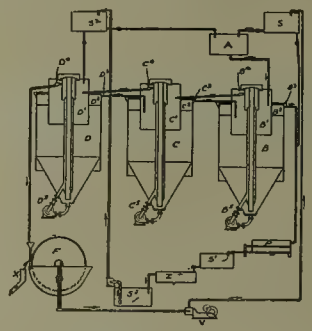
1,205,326. Art or Method of Treating Slimes. David Cole, Tucson, Ariz. Filed Apr. 12, 1913. Serial No. 760,702.



1. The art of separating crystalloids from slimes which tend to become flocculent, which consists in diluting the slime mixture sufficiently to insure the existence of spaces between the flakes for the passage of the crystalloid particles, allowing said particles to settle through said spaces and removing said flakes while in suspension from the settling zone and prior to the precipitation of any substantial portion thereof.

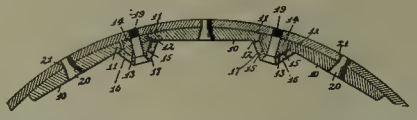
2. The art of separating crystalloids from slimes which tend to become flocculent, which consists in diluting the slime mixture sufficiently to insure the existence of spaces between the flakes for the passage of the crystalloid particles, holding said diluted mixture in a shallow depth or layer and allowing said particles to settle through said spaces, whereby interference by the flakes with the settling particles is minimized, and removing the flakes while in suspension from the settling zone and prior to the precipitation of any substantial portion thereof.

1,205,936. Leaching Ores and Other Products. John Edward Rothwell and Hugh Blackie Lowden, Denver, Colo., assignors to Colorado Iron Works Company, Denver, Colorado, a Corporation of Maine. Filed June 3, 1912. Serial No. 701,282.



A method of continuous leaching consisting in actively agitating a mixture of solids and solvent in a suitable vessel, continuously withdrawing solids with a portion of the liquid directly from said vessel while it is undergoing such agitation and passing the same to a following vessel, and at the same time continuously passing a substantially clear solution directly from said first named vessel to a preceding vessel.

1,207,174. Mill-Liner. Frank E. Johnson, Salt Lake City, Utah, assignor to American Manganese Steel Company, Augusta, Me., a Corporation of Maine. Filed May 27, 1916. Serial No. 100,218.



1. A liner comprising lining plates, lifting bars interposed therebetween, said lifting bars formed with base sections and with wear sections, said lining plates and lifting bars completely housing base sections.

2. A mill liner comprising lining plates, lifting bars interposed therebetween, said lifting bars formed with base sections spaced from the edges of the adjacent lining plates, and wear sections, mounted upon said base sections, secured thereto and projecting to opposite sides thereof.

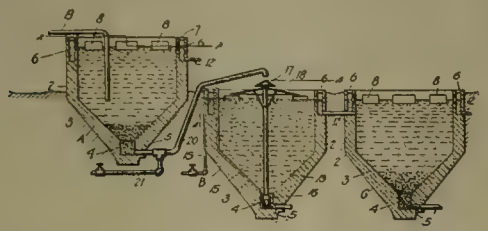
1,202,512. Method of Concentrating Ore by Flotation. Gustaf Gröndal, Djursholm, Sweden, assignor to Beer, Sondheimer & Co., Frankfort-on-the-Main, Germany. Filed Jan. 18, 1916. Serial No. 72,757.

1. The flotation method consisting in projecting a heated gaseous current having a selective agent diffused therein

against an opposed current or ore pulp, and collecting by flotation the particles thereby differentiated.

2. The method herein described of concentrating finely divided ore by means of oil flotation, said method consisting, essentially, in first distributing oil in a stream of heated gas under pressure and thereby atomizing the oil, then utilizing the flow of the gas-oil to commingle therewith a large quantity of another gas, and forcing the gas-oil mixture thus formed into a liquid against a counter-current of finely divided ore.

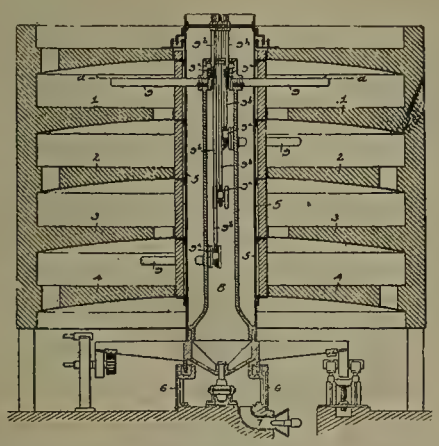
1,210,392. Decanting Apparatus. Julius H. Alpenfels, Denver, Colo. Filed Feb. 5, 1916. Serial No. 76,424.



1. In apparatus for settling solids out of liquid, a vat having an outlet for settling solids, a plurality of ports for the overflow of liquid rising out of the settling solids, a trough to receive liquid passing through said ports, and filters covering said ports.

2. In apparatus for settling solids out of liquid, a vat having an outlet for settling solids, a plurality of ports for the overflow of liquid rising out of the settling solids, a trough to receive liquid passing through said ports, and filters composed of screen-covered fabric, covering said ports.

1,208,249. Metallurgical Furnace. Utley Wedge, Ardmore, Pa. Filed Nov. 21, 1914, Serial No. 873,246. Renewed Apr. 27, 1916. Serial No. 94,055.

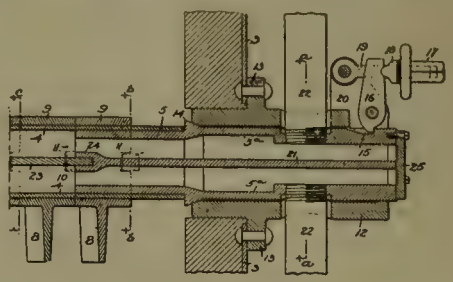


1. The combination, in a metallurgical furnace, of a casing having a hearth with a treating chamber above the same, a shaft, an arm projecting therefrom into said treating chamber and open at its shaft end, a valve sliding across said open end of the arm but otherwise rigidly mounted, and means for imparting such sliding movement to said valve, said means being otherwise rigid.

1,210,880. Process for Separating Precious Metals from Their Ores. William Henry Aghan, Burke's Flat, Victoria, Australia. Filed Dec. 9, 1914. Serial No. 876,350.

1. In separating precious metals from their ores—subjecting such ores to the action of a bath containing a solution of water, cyanid of potassium, sulfuric acid, corrosive sublimate, and common salt, in the approximate proportions described, other reagents capable of modifying the action on the bath being excluded.

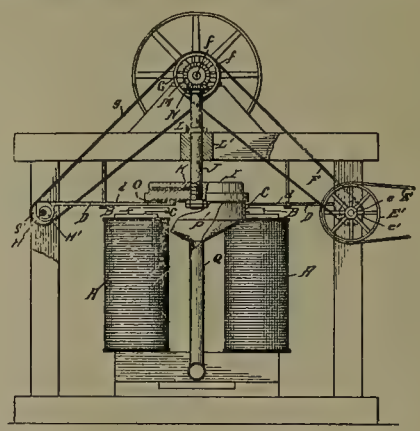
1,206,960. Rabble-Arm and Rabble for Metallurgical Furnaces. Utley Wedge, Ardmore, Pa. Filed Jan. 7, 1915, Serial No. 958. Renewed Apr. 27, 1916, Serial No. 94,056.



1. The combination, in a metallurgical furnace, of a central shaft, a sleeve carried thereby, a stub end structure carried by said sleeve and projecting into the furnace chamber, and an arm detachably mounted upon that portion of the stub end structure which projects into the furnace chamber.

2. The combination, in a metallurgical furnace, of a central shaft, a sleeve carried thereby, a stub end structure mounted in said sleeve, and projecting therefrom into the furnace chamber, said stub end structure being detachable from said sleeve, an arm detachably mounted upon that portion of the stub end structure which projects into the furnace chamber.

1,209,269. Magnetic Separator. Myron Dings and Robert A. Manegold, Milwaukee, Wis., assignors to Dings Electro-Magnetic Separator Co., Milwaukee, Wis., a Corporation of Wisconsin. Filed Aug. 11, 1911. Serial No. 643,504.



1. The combination with a set of vertically disposed electromagnetic coils having polar projections of opposite polarity at their upper ends, a horizontally rotating solid disk of magnetizable material having its outer portions located above said pole pieces and adapted to form a straight path for magnetic lines of force extending directly across from the space above one pole piece to the space above the other, means for rotating said disk and having means for feeding material containing magnetite through the gap between the pole pieces and said disk, said conveying means comprising a thin support for the material having but one thickness in the supporting member, whereby the dimensions of the air gaps are reduced to a minimum and a magnetic separator of high intensity produced in which the solid rotating disk forms an induced magnet rotating in close proximity to the pole pieces.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

PLATTEVILLE, WISCONSIN

SITUATION IN THE ZINC REGION DURING JANUARY.

Bad weather throughout January seriously interfered with mining and deliveries to smelters. There were other causes contributing to a lower output and restriction of development, yet these drawbacks failed to prevent a fairly good showing. Prices for zinc-blende at the beginning of the month held at $75 per ton for 60% ore, premium grades realizing $5 higher. No competition developed, and several smelter agents failed to put in an appearance, indicating that lower markets were expected. In the second week there was a drop to $72.50, with the range on medium and second-grade ores down to $70. Demand for lower-grade ore fell off, and mine-run product began to accumulate with most of the independent operating companies. A marked change for the better then manifested itself in the spelter markets, and almost without warning the third week found zinc ore advanced almost over one night $11 per ton, the price being $82.50 on standard 60% concentrate, with premium grades about $5 higher. This highly desirable condition prevailed until about the end of the month, when the quotation was $85, with premium grades at $90, when a war scare literally swept away all supporting props and a feeling akin to panic seemed to grip the market. Some of the refiners in the field, who had calculated that prices would take a sharp upward turn, had intentionally withdrawn considerable quantities of separator product, all of which was promptly marketed when prices seemed more nearly to their liking. The close of the month found no high-grade zinc product in bins, and sellers were pleased that advantage had been taken of the brief interval of higher offerings that immediately preceded the break between the United States and Germany. Many leading operators, personally interviewed regarding the situation in the field at the return of better prices, complained that operating conditions were distracting in spite of better prices for ore. Wages are the highest ever known, a genuine scarcity of labor, especially skilled classes of labor, is admitted, and supplies are in many cases from 40 to 60% higher than a year ago. The general manager of one of the largest producing groups of zinc mines here declared that lower metal and ore markets must necessarily mean a reduction in wages throughout the region. No relief is anticipated in the cost of supplies, but it will be practically impossible for producers to continue with the present wage-scale in force. On the other hand miners declare that the higher cost of living makes it imperative that good wages continue, and the outcome of the situation arising from the sea warfare is being awaited with considerable anxiety by all parties connected with zinc mining.

Lead ore producers were favored during January like the zinc miners. Prices commenced at under $90 per ton. Advances in the price of pig-lead, at one time up to 8c. per pound, raised prices for ore, and producers who had been holding their product sold a little ore at $100 per ton. It was intimated in well-informed quarters that prices would even exceed this figure, and the greater part of the ore mined during the month was carried over in bins in expectation of just such developments.

Continued high prices for sulphuric acid kept up the better offerings that prevailed for iron pyrite, but shipments for January were lighter than usual, about half. Refineries carried over a considerable quantity of fine, recovered in magnetic zinc-ore separation. This was partly due however to the improved prices for zinc-blende.

Producers of carbonate of zinc ore (locally termed 'dry-bone') lost the only outside buying interest represented in the field, and such ore as was offered for sale cleared through the old established channels afforded by the Mineral Point Zinc Co. The nature of the mill-feed precludes free handling of this grade of zinc ore during extremely cold weather such as has prevailed in this field, and production has been light.

Up to and including January 27 ore deliveries totaled 21,614 tons of blende, 215 tons of lead, and 1882 tons of pyrite.

EL PASO, TEXAS

IMPROVEMENTS AT THE A. S. & R. SMELTER.

The American Smelting & Refining Co. spent approximately $500,000 during 1916 in remodeling and improving its smelter here. It is officially stated that an additional $500,000 will be spent in enlarging the plant during the current year. The copper department has been greatly enlarged. A new 400-ft. stack is one of the latest improvements being constructed. A mechanical oil-handling system will be installed during 1917. Production of blister copper has given way to a method whereby copper bars are made ready for electrolytic treatment at Eastern refineries, instead of having to be re-melted. Two anode furnaces and a casting-machine make slabs weighing 600 lb., instead of the 300-lb. blocks. These are served by large electric cranes, carrying the molten metal from two new converters. The old steam tramway has been dispensed with in the copper department, and is used only for moving slag and serving the lead-furnaces. The 300-ft. reinforced-concrete stack for the copper plant was put in commission late in 1916. The old style reverberatory-furnaces that did service for several years have been displaced by the new anode furnaces. To carry off gases from the roasting-plant a brick stack, 30 ft. diam. at the top and much wider at the bottom, is being built to a height of 400 ft. Improved mechanical ore-feeders for the furnaces are to be installed. Additions to the machine-shops have been made. While the expansion of the smelter has been going on to take care of the copper business, the six lead-silver furnaces have been constantly in blast. At the beginning of operations by the company, which is known as the Kansas City Consolidated Smelting Works, lead-silver bullion was its only product. Revival of copper mining in New Mexico in the last few years demanded that the works be added to in order that the immense tonnage of copper ores be treated. The beginning of the enlargement dates from the contract made with the Chino Copper Co., which ships its concentrate from its New Mexico mine to El Paso. The converter-house, a steel structure, contains two Pierce-Smith converters, two anode furnaces, a casting-machine, and cranes. The roasting-plant consists of eight Wedge furnaces, each of 200-ton daily capacity. Oil is used for fuel. Coke from the Colorado and New Mexico coal-fields is supplied for reducing the lead-silver ores. Slag is moved by steam tramway from the furnaces to the dumps on the north side of the smelter hill. Electric power for motors and lights is generated by Corliss engines. A good-size lake on the top of the hill, replenished by a pumping-system from the Rio Grande, supplies water to the boilers. Normally the smelter employs between 1400 and 1600 men, but during the past few months the force has been increased to nearly 1800. The monthly payroll is over $100,000.

MELBOURNE, AUSTRALIA

A Review of the Australian Mining Industry

Australian mine operators have had an eventful year. Shortly after the War began, the Prime Minister, W. M. Hughes, realized how completely the metal trade of the Commonwealth was in the hands of German firms like Mertons, Aaron Hirsch, Beer-Sondheimer, and others, and started transferring this control to British concerns. At first he met with some open opposition and a lot of passive resistance, but he showed that the power vested in the Federal Government under the War Precautions Act was not to be flouted. Some of the old Australian and London friends and company partners in many a mining and share deal of the German ing, and it is expressly stipulated that they must not be members of any stock-exchange. For the most part the members are either the directors of the large base-metal mining companies or firms of British origin that had a pre-War connection with the metal trade. The peculiar part of this organization is that while members of the stock-exchange were taboo, their closest associates and actual partners in share transactions or in the control of mines may belong to the organization. It has now been in existence for a year or so, and as all the metals produced in Australia must pass through its hands for sale, the members are a highly satisfied body of men. No wonder when Mr. Hughes returned from America they deemed him the subject of special laudation, though a year before, more than one of the members would have torn

THE 1060-MILE RAILROAD ACROSS THE CONTINENT WILL BE FINISHED AT AN EARLY DATE.

metal firms kicked, but among their ranks were two or three men of discernment. These saw that if the War continued there must be an adjustment of trade relationship. They perceived further, that, with a Labor government in office in Australia, there was every risk that if the situation Mr. Hughes was creating was not skilfully turned, there would be the possibility of a socialist domination being established. Then the business that had been built up during the previous decade with such skill and profit would be dispersed. This meant interference with large interests in the big group of Broken Hill silver mines and regulating—in the interest of the State—the expanding copper trade of north Queensland and southern Australia. If Mr. Hughes had selected as his instrument to investigate, and advise, a man at all tinged with his own party ideals, a State organization would have been ensured. As it was, he impressed a man of fortune and of probity as his adviser—one skilled in metallurgy, possessing doggedness of disposition and ability. Whether he suggested the Metals Exchange or not is not at all clear. If he did, the Prime Minister fell in with the idea most readily. This organization is now established to deal with the metal output of Australia. Its members have to show a good financial standhim to pieces for even daring to suggest the control of the metal trade through such an institution as the Metals Exchange. Whether this Exchange will last after the War will depend on more than one factor. If the Allies win, and carry out an effective trade combination, which will involve the exclusion of subjects of the Central Powers or neutrals from participation in the trade of the British dependencies, then it may continue. Or, if the Commonwealth government decides that it will place an export duty or restrict the export of metals to only Allied nations, the organization may persist. But some big international problems may have to be settled if action of this kind be taken. One point that will have to be determined will be whether the patriotic impulses of the members comprising the Exchange will be sufficiently shown for those who were not pro-British before the War to reject business overtures that may be extended to them. Of course, if the State had taken the trade into its hands then it would have been able to act as it liked, appoint its own agents, and nominate their business. As it has not done that, the future is full of business intricacies.

Out of the same series of events came the Zinc Producers' Association. This is another child of Mr. Hughes, and of his

adviser. Its birth was not without travail; for the Prime Minister or his deputy, the Attorney-General, had to compel the co-operation of the Broken Hill Proprietary and the Mt. Lyell companies, as these apparently had decided at the last moment to keep out of the organization. No one quite knows what were the motives, but had they been stubborn, it is almost certain that Mr. Hughes's arrangement with the British government to purchase a quantity of the zinc concentrate or spelter would have been checked. Anyway, the companies fell into line and the Zinc Producers' Association stands as another creation of the War aimed directly at wresting from the Germans their trade in the zinc products of Australia. It must not be supposed that the two companies just named were pro-German. They would have been ready to give any guarantee to trade only with British firms as refiners. That being so, it can be assumed that what they desired was to retain the handling of their own products. However, these have to go to the Zinc Producers' Association. This body, like the Broken Hill Associated Smelters Co., is described as being a co-operative body; that is, the profits of all the business transacted are to be divided among the companies or mines that subscribe or are affiliated with the organization. Great care has been taken to make these controlling concerns proprietary companies, so that their balance-sheets will not reach the eye of the public, or, for the matter of that, be disclosed to the shareholders of the co-operating companies. They may pass to their directors, but that is the most. In consequence, no one outside can know how costs are going, what are the management charges, or the fees paid to directors. To the lay mind the Zinc Producers' Association, the Metals Exchange, and the Broken Hill Associated Smelters appear to be a fusion of the interests at present commanding the output of the leading base-metal mines of Australia. How they would stand in the event of new mineral discoveries will rest on the power to control exports and internal trade under peace conditions.

In the meantime great importance attaches to the experiments set in train to utilize the cheap water-power of Tasmania for the manufacture of zinc electrolytically. To assist in the solution of the problem, the Amalgamated Zinc (De Bavay) Co. sent H. W. Gepp, its general manager to the United States to investigate. That official has returned, and has brought with him sundry experts. A company with a capital of £100,000 has been formed to carry on the initial experimental work near Hobart, under the most advantageous terms, so far as cheapness of power goes. It is expected that this venture will include the Broken Hill South, the North Broken Hill, the Amalgamated Zinc, and perhaps the Zinc Corporation, belonging to the Hoover-Govett group of London, as all these silver-lead-zinc interests have for a considerable time past co-operated in a number of enterprises. The Broken Hill Proprietary Co. has almost exhausted its mine at Broken Hill, so it is not the important factor in the zinc market it once was. The other big producer of the future is sure to be the Mt. Read & Rosebery Co., formed a month or two since to take over the zinc-lead silver mines at Rosebery in Tasmania. These comprise the Hercules, Tasmania Copper, and Primrose mines. Their reserves have been estimated by one of the members of the State Geological staff as follows:

	Blocked out, tons	Probable, tons	Total, tons
Hercules	273,000	391,000	664,000
Tasmanian Copper	185,000	341,000	526,000
Primrose	33,500	49,000	82,500
Total	491,500	781,000	1,272,500

The average assay of 263,000 tons mined in these mines to date is 29.79% zinc, 8.89% lead, 12.16 oz. silver, and 0.17 oz. gold per ton. Mr. Hills considers that the ore reserves may be accepted as agreeing in average composition with that already broken. The Mt. Lyell company has done a good deal of boring since it got possession of the mines, and has made a substantial addition to the reserves. Further, it has sent a consignment of ore to Broken Hill to ascertain if it is amenable to flotation treatment. These experiments have been most encouraging, and confirm the work done by the staff of Messrs. Bewick, Moreing & Co. under the guidance of Mr. G. C. Klug when the Tasmanian Copper Co.'s lease was under offer to a strong European-Australian syndicate before the War started. It does not appear as if the Mt. Lyell company will get its power from the Great Lake scheme of the Tasmanian company, on which the Broken Hill group relies, but will seek to utilize some of the streams and lakes on the west coast of Tasmania to generate power for itself, as it is already doing from Lake Margaret for its mine and smelter. Estimates show that it should be able to obtain power at a low figure. No doubt now that the Mt. Lyell's properties are in order and the Tasmanian government has given it a most favorable enabling statute, it will rapidly develop its scheme for handling the resources of the important district that it will control through the Mt. Read & Rosebery Co. One step is sure to be taken, that is, to secure the services of a man highly qualified in the electrolytic treatment of such ores as those of the Rosebery field, and the expectation is that he will come from the Anaconda staff at Butte.

So far as copper mining goes, little need be said. The only district where any development of importance is occurring is Cloncurry, in Queensland. There the Hampden company has been proving the existence of fair reserves of pyritic ore beneath the rich masses of copper glance in the upper levels. As a set-off, however, the Duchess mine below the 700-ft. level is not encouraging. This leaves the company to rely on its Trekalona and Pindora properties to fill the gap. The ore of the latter group is highly silicious, and concentration is to be by flotation. The first unit is at work, but results are not known. Then the London and Paris, owned by the Mt. Elliott company is developing a large group of mines, both on its own behalf and for a subsidiary company. The most promising results have been from the Dobbyn near Mt. Cuthbert, while the well-known Mt. Oxide mine is also being steadily developed. It, however, is too far off to figure as a factor until transportation facilities are improved. Among the old-established mines the Great Cobar in New South Wales is unable to show satisfactory development. This also is the position of Mt. Morgan, whose pre-War estimates had to be greatly revised. Wallaroo & Moonta in South Australia plod along, proving the soundness of the adage that a good mine is difficult to kill. Progress at the Mt. Lyell group proper has been satisfactory, that is to say, that developments have more than maintained ore reserves, which are equal to over eight years' life at the present capacity of the smelters. From time to time reports come to hand of discoveries of new copper deposits in northern Australia, outside of Queensland, but none of these have materialized into anything important. What has been done at the instance of the Federal government is the formation of a company to turn to account the supply of raw metal so that Australia shall engage in the manufacture of articles in which copper is the leading element. British capital is interested in this concern.

Evidence is not wanting that the tin resources of the country are being steadily depleted. At the Mt. Bischoff mine in Tasmania the main deposits are greatly reduced, and it is inevitable that the company will have to rely more and more on the tin it can extract from the alluvial at the foot of the mountain, and any new shoots it may succeed in opening on its north side. So far as alluvial tin goes, north-eastern Tasmania is the main source of supply; but here, too, resources are shrinking. The same is happening in northern Queensland and in New South Wales. A gleam of hope comes from the Northern Territory, where some discoveries have been made, but so far the yields have lacked persistency. This

also is the case in Western Australia. Still, both of those States have such immense areas of undeveloped and unprospected territories that there is always hope of a lucky find. Diligent search is being made for tin, as it is considered that prices are at their lowest. The high prices for wolfram and molybdenum is stimulating the extraction of these metals, the output of which is under the control of the Federal government for War purposes. The other branch of the industry is gold mining. Unfortunately not a single development of importance has taken place since the Edna May group of mines was opened in Western Australia. Kalgoorlie is drawing on reserves rapidly, all the Queensland centres are much on the down-grade, and in Victoria and New South Wales the position is deplorable. Arising out of this condition of affairs one of the ablest among Victorian junior mining men, Mr. E. A. Dyason, has evolved a scheme for consolidating a group of Bendigo mines on the main central line of 'saddle' formations into one company. The area to be controlled is 1 by 5 miles. The only objection that can be offered to this consolidation is that labor conditions may not be fulfilled to the extent that is necessary in the interests of the field. The State no doubt will attend to this matter before it grants any such a consolidation as is suggested. What Mr. Dyason aims at is to secure cheaper working, more effective control, the centralizing of surface equipment, and the introduction of more scientific mining methods.

Taken as a whole, the outlook for mining in Australia is the reverse of encouraging. Only one field of importance is emerging from the lot, namely: the Mt. Read and Rosebery in Tasmania, controlled by the Mt. Lyell company. Prospecting is almost a lost avocation, on account of the general state of the industry for the last decade. The huge expenditures on public utilities by State governments have led to the diversion of men from mining to less hazardous occupations. The outbreak of War caused the staffs at a number of mines to be reduced, owing to the volunteering for military service. There also has been restriction of credit and of the promotion of companies. Above everything, however, has been the militant attitude of the labor-unions. These have demanded, and been supported in their demand, by the Federal Arbitration Court, for increases in wages of from 25 to 50% on pre-War rates. With the grade of ore decreasing as depth is attained, it is only the base-metal side of the industry that can sustain such a burden. In its case the high price of metals enables the mines to bear the extra charge and make large profits. What will happen after the War nobody knows. It looks as if the gold output of the world is decreasing everywhere. If that be so, great economic issues are involved, amid which gold mining will not suffer. The increase in the world's yield of gold put up the price of commodities. A decrease will have the reverse effect, to come on top of the confusion occasioned by an adjustment of the national finances after the War. There may have to be a marking-down in the price of lead, copper, and other metals, because of the declining supply of gold. Accepting this deduction as correct, and recognizing that the borrowing policy of Australia must be greatly curtailed because of the smaller supply of capital available in London, there will be a huge reduction in public expenditure in Australia. [The total debt of Australia is £490,000,000.—EDITOR.] This will throw out of employment an army of workers. It is "a guinea to a gooseberry" that many of these will return to mining. They will search for gold, silver, lead, and copper. So, while economic problems may be disturbing to the politician and to the theorists who created the Arbitration Court, the net result of hard times may be to give Australia new gold or base-metal mines, owing to the forcing of men into prospecting the distant parts of its vast unexplored territory.

The Zinc Corporation in December treated 16,870 tons of zinc tailing by flotation, and 14,211 tons of lead ore by concentration; yielding 4065 tons zinc and 3372 tons lead concentrates.

LEADVILLE, COLORADO

SILVER DISCOVERIES.—DOWN TOWN AND OTHER AREAS.

Several new and important discoveries of ore made recently have given added impetus to development in this district, especially in the outlying sections away from the central area that has been fairly well prospected. In the St. Kevin section the Griffin property is the scene of the greatest strike that has been made here for many years. The cutting of a new vein several weeks ago was looked on as important, but it was not thought to be of such unusual value as development has proved. The vein, where opened, was 8 ft. wide, and assayed $75 per ton in silver. Driving on the ore-shoot has continued for over 200 ft., and several raises were driven a height of 275 ft. without reaching the top of the shoot. The value of the ore has increased remarkably, the average now being shipped carrying 160 oz. of silver. Bunches of high-grade ore have also been found in the vein, which appears to be the most persistent and richest discovered in the area. Production is 50 tons daily, and as soon as facilities for extracting a larger output are complete this quantity will be increased. New bunkhouses and an assay-office are under construction. The property is about five miles west of Leadville, and two miles from the nearest railroad siding.——A discovery has been made in the Dinero property on Sugar Loaf. Lessees have opened a small vein assaying as high as 531 oz. of silver per ton, while the lowest is 35 oz. The shoot has been opened for several hundred feet. The weekly output is 40 tons.——Development of the new vein opened in the Bartlett mine on Sugar Loaf indicates that the discovery rivals that at the Dinero in value, while the size of the vein is several times as large. The installation of an electric hoist at the collar of the interior shaft is now in progress. As soon as this is done mining will be undertaken on a larger scale.

The discovery of high-grade carbonate of zinc in the Down Town mines is a recent event of importance. A large body of 30% ore has been opened and regular shipments are being made. One hundred tons of iron-manganese ore is being extracted in addition to the zinc, and it is stated that if railroad cars could be secured the property would produce 200 tons.——James Daniels, well known here, has organized a new company and secured a sub-lease from the Down Town Mines Co. on the Grey Eagle, Crown Point, and Wildcat claims, east of the Penrose on Carbonate hill. Large bodies of high-grade silver-bearing iron and iron-manganese are known to exist in the Grey Eagle. The property is famous in the early history of the district as a heavy producer of high-grade silver and lead carbonate ores. It has been idle for over 20 years.

Unwatering of the Greenback in Graham park is completed, and station pumps installed at the bottom and 900-ft. levels are handling the water. The shaft, 1350 ft. deep, is the deepest in the district and is in the centre of one of the richest ore-zones. When this mine was closed several years ago on account of water it was said that there was a large quantity of ore blocked out in it. Exploration is now to be started under P. Mulrooney; it is expected ore will soon be shipped.

The La Plata property on Rock hill, which was recently drained by W. E. Bowden and others, is the scene of another new discovery, an extensive body of zinc carbonate being cut on the 500-ft. level. Development shows promising indications. A great deal of the ore is low grade and is shipped to the Western Zinc Oxide Co.'s plant here. Higher grade material is being shipped to zinc smelters outside of the State.

The old A. Y. & Minnie mine in California gulch is being operated by lessees, who are extracting a large tonnage of low-grade zinc carbonate. A contract for 3000 tons has been closed with the Western Zinc Oxide Co.

The Mt. Champion mine in the Lackawanna district continues to produce steadily high-grade gold ore. The mill has been closed for the winter, but it is stated that the plant will be enlarged during the spring and summer.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

In the annual report of the Board of Road Commissioners for Alaska it is stated that since 1905 the sum of $3,390,123 has been spent on roads in the Territory. These include 920 miles of wagon-roads, 629 miles of winter-sled roads, and 2210 miles of trail. These cost respectively $3144, $345, and $106 per mile. The wagon-roads are good for all the year heavy traffic. Over 250 motor-cars and trucks are used on the roads, including a regular mail and passenger service between Valdez and Fairbanks. Details of the past year's work is given in the report.

CHICHAGOF. The Sea Level Mining Co., operated by Fleming brothers on the west coast of this island, are developing a deposit of high-grade copper-nickel ore.

JUNEAU. December returns of the mines on Douglas island are as follows: Alaska Mexican—$18,284 from 11,739 tons of ore, giving a profit of $4026, including sundry revenue; Alaska Treadwell—$53,041 from 24,843 tons, and $23,058 profit; and Alaska United—$86,375 from 43,974 tons, resulting in a loss of $41,096. Diamond-drilling from the 2300-ft. level of the 700-Foot Claim gave the following: No. 3, for 22 ft. averaged 29c. per ton; No. 4 for 550 ft., $1.65; and No. 5 for 22 ft., $1.29.

ARIZONA

KINGMAN. In the Maynard district, east slope of Wallapai mountains, 20 miles south-east from Kingman, the Telluride Chief Mining Co. of Los Angeles has been developing and equipping its mine for 11 months. The company has opened a large tonnage of high-grade molybdenite ore, which with adequate milling plant will place the property in the front ranks of molybdenum producers. For this purpose an issue of treasury shares is to be made.

MIAMI. During January the Inspiration Consolidated mined 516,000 tons of ore, while the mill treated 523,000 tons. The company is making experiments in leaching the oxide ore.

The International smelter is to be enlarged by another reverberatory furnace and accessories.

OATMAN. The manager of the Gold Ore Mining Co., A. C. Werden, announces that he will send samples of ore for flotation tests to the Minerals Separation's San Francisco laboratory. If results are good the company may construct a flotation instead of cyanide plant. Oatman ores are ideal for cyaniding. As a rule the gold is fine, and the ore is crushed to 200-mesh, giving 96% recovery. Flotation, however, is less costly for installation and operation. With cyanide selling at 75c. per pound, and the supply limited, operators are inclined to investigate the merits of flotation.

The Big Jim shaft has passed the 600-ft. point and will have the sump completed and a station cut by the end of the week. Cross-cutting will be started and the vein opened at 90 ft. from the shaft. The cross-cut will be extended through the vein, and drifts driven east and west to the end of the ore-shoot. The 600-ft. level is considered likely to disclose some streaks of rich ore. As soon as the ore on this level is sufficiently developed to permit of sampling, mill tests will be made. The company contemplates the construction of a 400-ton mill.

A choice piece of ground adjoining the Tom Reed on the east, west, and south, and thought to cover the extension of the Tom Reed-Grey Eagle vein system, is to be vigorously developed by the Red Lion Mining Co. The shaft has been sunk 40 ft., a head-frame erected, and a hoist purchased.

The Gold Road Bonanza is driving on the vein, which was cut at 506 ft. in the shaft, at the 550-ft. level. At 525 ft. the vein left the shaft. An average of 60 samples taken between the 506 and 525-ft. points was $30 per ton. The width of the ore-shoot increased from 18 to 36 inches.

The cross-cut tunnel at the Crescent is being driven for the main Crescent vein. The face is in andesite cut by stringers of calcite, indicating proximity to the vein. Cross-cutting continues in vein-matter on the 400-ft. level at the Adams. The cross-cut has been in vein-matter for 75 feet.

At the old Moss mine the Santa Gertrudis Corporation, Ltd., is down 500 ft. in the second diamond-drill hole at an angle of 60°. Reliable, but unofficial information, is that the first drill-hole cut a 12 ft. vein at 500 ft. The Moss produced $240,000 from a shallow hole where a fault cut the vein 50 years ago. Subsequent work through a cross-cut tunnel failed to open the vein at depth.

CALIFORNIA

AMADOR CITY. On February 6 two miners were killed in a runaway skip in the Treasure mine. Negligence is charged one of the engine-men, as when the hoist brakes were thrown off, the clutch was out of gear, allowing the skip to break away.

CLOVERDALE. The Culver Bear company is employing 40 men at its quicksilver mine. A 5-ton furnace is in operation, but a 25-ton unit is nearly ready to start treating cinnabar.

COPPEROPOLIS. The Calaveras Copper Co., S. M. Levy in charge, is to construct a railway from its mine to Milton, the present nearest terminus.

GRASS VALLEY. At the Champion mine flotation tests are to be made on tailing in Deer Creek.

The Matteson ranch of 440 acres has been sold by J. J. Keeney to the Brunswick Consolidated for $60 per acre. Part of the land is to be used for tailing storage.

MARYSVILLE. Some of the supervisors of Yuba county are protesting against the application of F. R. Ritchie, who desires to mine by hydraulicking at Howland flat, Sierra county, and impound the débris behind the concrete dam constructed across Slate creek, a tributary of the Yuba river. W. J. Mellon and W. J. Forbes, supervisors representing the mining industry in the county, disputed Supervisor Hyde's contentions.

(Special Correspondence.)—The McAlpine Mines Co. has acquired five additional claims which will be operated in conjunction with its original holdings, known as the McAlpine mine. The properties are situated near the Tuolumne-Mariposa boundary line.

The Black Oak company has made another rich discovery. The new orebody was found close to the line of the Live Oak claim, on the 1300-ft. level. The ore is of the same general character and appearance as that of the orebodies which made the mine famous during recent years.

Work has commenced at the Rawhide No. 2, recently acquired by H. H. Stambaugh and R. C. Steese. Buildings, head-frame, and other surface improvements are under way. J. Packard, until lately holding a position at the old Rawhide mine, has been appointed superintendent.

A claim that gives promise of becoming one of the great mines of Tuolumne county is situated on Shipley flat, two

miles from Chinese. It is being developed by Rowe and Packard. At a depth of 30 ft. the vein is 4 ft. wide, and particles of gold can be seen in almost every piece of rock broken. It is said the ore will probably yield $200 per ton. Placer gold to the amount of at least $1,000,000 was taken out of the immediate surroundings during the early days.

Development in the Basin mine, near Columbia, has been retarded by a sudden heavy inflow of water encountered while driving a drift toward one of the underground gravel-channels in the property.

Sonora, February 3.

(Special Correspondence.)—The main shaft at the Old Eureka mine has been unwatered to a point 50 ft. below the 1600-ft. level, and will soon be dry. Shaft work is using 50,000 ft. of lumber monthly. The new head-frame has been completed, sheaves put in place, and ore-bins built. The structure rises 110 ft. from the ground, but the height will apparently be decreased 32 ft. when the platform is built at the top of the concrete piers and the ground filled in around the collar of the shaft, this platform to be on a level with the engine foundation. The new hoist can be started as soon as motors arrive and are installed.

The Central Eureka is increasing the depth of its shaft 50 ft. below the point where the shaft cut ore. Some ore showing free gold is being extracted from stopes above the 2825-ft. level.

The California Clay Corporation, recently organized, has secured a 50-year lease on 30,000 acres in the Arroyo Seco grant from the Ione Coal & Iron Co., and will build a $65,000 factory near the Southern Pacific station at Ione for the manufacture of fire-brick and other clay material. The plant is to have a capacity of 3,000,000 bricks annually and a yearly pay-roll of $30,000. The clay deposits at Ione are of great extent, and certain desirable elements for the manufacture of fire-brick equal to the best on the market. The new company will make a bid for supplying the United States navy, which uses each year 1,000,000 fire-brick on the Pacific Coast. Officials are: George C. Hallerton, San Francisco manager for the Pacific Gas & Electric Co., president; Arthur S. Cunningham of Ione, vice-president and general manager; Jas. R. Keith of San Francisco, secretary; and E. V. McGinto of San Francisco, treasurer.

The question of the State's title to the Royal Consolidated property at Hodson, Calaveras county, is to be decided among other points by Judge Shields of the Superior Court. The property was taken over by the State for unpaid taxes, but the defendants allege that the State's title is faulty. Operations were resumed at the mines and ore extracted since the State acquired title, and the State is suing for the possession of the ore for an accounting.

Sutter Creek, February 11.

COLORADO

Central City. The American Smelting & Refining Co. issued a new schedule last week, applying to Clear Creek, Gilpin, and Boulder counties, in which the treatment charges for all classes of ores have been reduced 50c. per ton. The W. J. Chamberlain Ore Co., having sampling works at Black Hawk, Idaho Springs, Georgetown, and Boulder, also issued new schedules of rates, similar to those given of the smelter. In comparing the new rates with those adopted by the Argo mill at the mouth of the Newhouse tunnel at Idaho Springs, it is found that they are almost the same as charged by the Argo plant.

Cripple Creek. Gold output of the district during January was $1,169,188 from 74,706 tons of ore. Dividends totaled $342,941. Excessive cold weather curtailed production of several small mines.

The Roosevelt drainage-tunnel was advanced 160 ft. in 24 shifts. The face is now in the Phoenix claim of the Ramona company. The flow of water is 8000 gal. per minute. The Cripple Creek Deep Drainage Co. has decided to continue the tunnel to the Portland mine, as the Vindicator company requires all the water from its mine for the mill.

During 1916 the Isabella Mines produced 19,377 tons of ore worth $412,962, of which lessees (30 sets) mined 16,573 tons valued at $258,688. The company's profit from all sources was $66,663. A dividend, the first, of 1% was paid. Development covered 18,587 ft., an increase of 1298 ft. The most important result was the discovery of rich ore on the bottom level of the Lee shaft. An ore-house, costing $12,000, was erected. The mill was operated since October on ore assaying $3 per ton. The recovery from 1500 to 2000 tons monthly is 70%.

Published in *The Electric Journal* for December 1916, W. N. Clark of the Arkansas Railway, Light & Power Co. discusses electricity applied to metal mining. Service to Cripple Creek was begun in 1898. Lighting at that time cost 20c. per kw.-hr. Only small motors were used at first, with comparatively high rates. Storms interrupted the supply of power in the winter, also damaging transformers, meters, and motors. Four central stations competed with one another for business. The aluminum cell-arresters next enabled electric companies to give reliable service, air-compressors, mills, and other large consumers being connected up. In 1911 the Arkansas company took over most of the plants, and now operates three in parallel—one at Pueblo, one at Canon City, (both steam), and one hydro-electric near Victor. The load for the lot is heavy, Cripple Creek and coal mines at Canon City using 16,000 hp. The motors drive a variety of machines. There are no large electric hoists, the biggest being 200 hp. Storage-battery locos are used in the Portland mine.

Georgetown. The Imperial mill, operated by Campbell & Co. has received two ball-mills, a 6-cell M. S. flotation machine, a 36-in. Akins classifier, a 3 by 4½-ft. Oliver filter, and a 60-hp. motor. The plant is being reconstructed to embody flotation.

Leadville. In the Down Town property (Penrose shaft) a considerable quantity of zinc carbonate is being opened. Shipments of iron and manganese ore continue to be made.

The old Grey Eagle mine on Carbonate hill, near the Down Town mines, is to be re-opened by lessees in charge of Joseph Daniels. Equipment is being erected, and re-timbering of the shaft started.

Silverton. This district shipped 201 cars of ore and concentrate during January, a record for that month.

Telluride. During January this district shipped 110 cars of ore and concentrate, as follows: Inama-Periono lease, 1; Liberty Bell, 13; Smuggler-Union, 36; and Tomboy, 60 cars. The new flotation annex at the Smuggler plant is nearly finished.

IDAHO

If the bill passes the State Legislature a bureau of mines and geology will be created for this State, to act in conjunction with the State University.

In the *General Electric Review* for February, Ben Olsen discusses the application of electricity to mining in the Coeur d'Alene. The region, until recently, was served exclusively by the Washington Water Power Co. Now the Montana Power Co. supplies some current. In 1903, when 260,900 tons of ore was mined, the power consumption of the Bunker Hill & Sullivan was 288,000 kw.-hr. per year; in 1915, when 455,000 tons was extracted, there was 10,979,000 kw.-hr. consumed. Substation capacity increased 15 times. In 1915 mine properties used 29,508,711 kw.-hr., for which was paid $214,190. Milling requires the largest proportion of the load at each mine. The article mainly deals with the utilization of power at the Bunker Hill & Sullivan mine.

Elk City. In the Marshall Lake district the Fox mine is yielding $1000 of gold daily. In three months the total was $76,000.

KELLOGG. The Douglas zinc mine in the Pine Creek district, operated under lease by the Anaconda company of Butte, is shipping 30 tons of ore daily. A compressor is being installed. Nearly 50 men are employed. A royalty of $3 per ton is paid the Douglas company by the Anaconda.

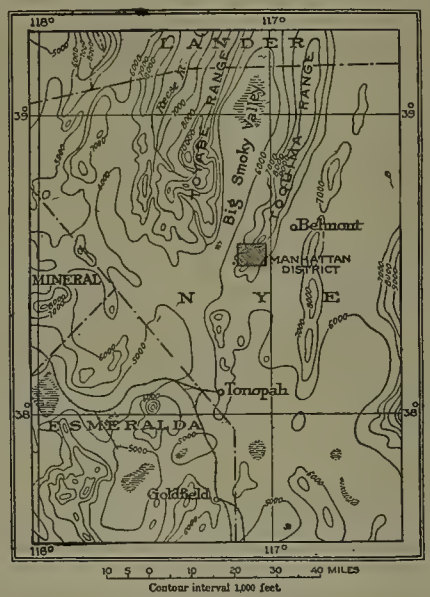
MISSOURI

JOPLIN. Owing to a slump in spelter the zinc-ore market declined $10 per ton last week. A sudden severe cold spell reduced operations 75%. The output of the Missouri-Kansas-Oklahoma region was 6759 tons of blende, 439 tons of calamine, and 1174 tons of lead, valued at $688,497. For five weeks the total is $3,331,807.

NEVADA

A bill before the State Legislature provides for a State assayer and inspector at a salary of $3000 per annum. He is to be appointed for four years, and can employ deputies at $5 per day. The duties of the new position are to watch and check consignments of ores to smelters for shippers.

From March 1895 to the end of 1916 the Nevada State Mining Laboratory has made 57,357 determinations on 14,825 samples of rock submitted by 7654 individuals. For 10 years



PART OF NEVADA, SHOWING SITUATION OF MANHATTAN.

the institution was little used, but from 1901 it became of importance. During 1916, 1651 people sent in 3236 samples, necessitating 12,565 determinations. This is 50% above 1915, which was 25% greater than in 1914. The present daily rate is 7 samples. V. M. Henderson is doing most of the work at the laboratory.

GOODSPRINGS. The report of F. A. Hale, Jr., general manager of the Yellow Pine Mining Co., contains the following concerning 1916:

The Bybee mine produced 22,662 tons of ore at a cost of $3.81 per ton. Of this, 2081 tons was shipped and 20,581 sent to the mill. Development, 3358 ft., cost $9.31 per foot. The 300 sub-level opened high-grade ore. A winze below this passed through 50% zinc-lead ore. A cross-cut and raise on the 700-ft. level are to develop this orebody. The mill treated 20,581 tons of ore averaging 10.5% lead, 30.4% zinc, and 4.53 oz. silver per ton, at a cost of $1.66 per ton. There was shipped 2294 tons of lead concentrate containing 54.2% lead, 13.2% zinc, and 20.2 oz. silver; 14,240 tons of zinc concentrate assaying 4.48% lead, 32.22% zinc, and 2.27 oz. silver; and 3570 tons of zinc-slime with 6.25% lead, 33.5% zinc, and 3.6 oz. silver. The crude ore carried 6.25% lead, 37.6% zinc, and 3.42 oz. silver. Net receipts totaled $986,315. Total costs were $9.919 per ton, and profit $34.537 per ton. Dividends amounted to $800,000. The bank balance is $58,124, and special reserve fund $94,000. It is intended to produce on the same scale during 1917.

MANHATTAN. Placer deposits of this district are described by H. G. Ferguson in Bulletin 640-J of the U. S. Geological Survey. Gold ore was discovered at Manhattan early in 1905, since when over $3,000,000 has been extracted, probably too low a total. Placer mining contributed $1,000,000 to this amount. The gravel deposits are of three types, namely: the old gravels, still existing in small patches along the side of Manhattan gulch above the present stream-level; the deep gravels of the gulch; and the surface wash and shallow stream-gravels in the immediate vicinity of the lode outcrops. The placers are all worked by drift mining, as the overburden is too thick for dredging or hydraulicking, even if there were sufficient water available. There is a constant flow (20,000 to 50,000 gal. daily) of water through the pay-gravels along the greater part of the deep channel. This water is used for washing the gravel in the sluice-boxes. Tramming is done mostly by barrows. The cost of mining at a well-equipped property is rather more than $1 per cubic yard. Most of the work is being done by Serbian and Italian lessees. The dry-washing machines recover only 70% of the gold, the wet methods much more.

NEW MEXICO

The Oaks Company paid its third monthly dividend on February 1. An option has been taken on the Maud S. mine, which has produced $500,000 in the past.

STEEPLEROCK. It is authoritatively stated that August Heckscher (of New Jersey Zinc Co.) and associates have purchased the controlling interest in the Carlisle Mining Company. The mine was originally owned by Marshall Field, L. Z. Leiter, and N. K. Fairbanks, of Chicago, and was a large gold producer during the early eighties, with a production record of over $6,000,000. About 1887, the Carlisle was sold to a London exploration company, which operated it for several years. As depth was reached, the ores become a mixture of gold, silver, copper, lead, and zinc, impossible to treat profitably by any known method. The Carlisle was closed in 1890, and allowed to fill with water. The present owners have unwatered the mine and have discovered a large quantity of ore, all of which is now amenable to profitable treatment under improved metallurgical processes. A 125-ton mill is now being erected on the property, and is to be enlarged several times that capacity.

OREGON

KERBY. The black-sand plant of T. W. Gruetter makes it profitable for miners to save their concentrates and have them treated there for recovery of rusty gold and platinum. Some miners send their black sand without first panning or amalgamating, thus saving time for sluicing.

TEXAS

EL PASO. The suit tried in the 41st District Court by Judge Price before a jury on January 8 was brought by C. A. Bentley in the name of the San Roberto Mining Co. of Zacatecas, Mexico, against the American Metal Co. and Penoles Mining Co. for breach of contract. The American Metal Co., through a subsidiary company, Minerals y Metales, had made a contract for the purchase of 10,000 tons of zinc ore from the San Roberto properties on March 27, 1915. The metal company broke this contract, alleging many and diverse reasons for doing so. Mr. Bentley brought suit against the company for breach of contract, and asked for $390,000 damages. The jury,

by a unanimous verdict, gave him approximately $70,000 damages, a verdict rendered at El Paso on January 13. It is thought that this is only a beginning of a number of other suits. It is not known at this time whether or not the defendant companies will appeal.

UTAH

ALTA. The tunnel of the Alta T. & T. Co. is in 2400 ft., in favorable formation with a strong flow of water from the face.

AMERICAN FORK. Mine operators in the American Fork district are making plans for the establishment of the American Fork Bureau of Mines for the purpose of giving publicity to the legitimate opportunities of the mining industry in that district, and to disseminate accurate and official information regarding the objects and progress of development plans being carried out at the various properties. The Bureau will have offices in the Salt Lake Stock & Mining Exchange building.

PARK CITY. This growing district produced 6943 tons of ore and concentrate during January. The Silver King Coalition led with 2313 tons, followed by Judge Smelting with 1210 tons, Silver King Co. with 1035 tons, and Daly West with 864 tons.

TINTIC. This district produced 40,000 tons of ore and concentrate in January, worth $1,000,000. The Chief Con. led with 7000 tons, followed by Dragon Con. 6600, Iron Blossom 5000, and Centennial Eureka 4500 tons.

CANADA

Dividends paid during January totaled $1,255,580. Companies paid $854,392 from Cobalt, $306,000 from Porcupine, and $65,188 from Kirkland Lake.

COBALT. The Beaver Consolidated has cut 6 to 8 in. of rich silver ore on the 1600-ft. level. This is at the lower contact. This is of great importance to the mine and the district. As the Temiskaming company is also exploring along the contact, these two mines are to be connected at 1600 feet.

MEXICO

Companies operating in Mexico are annoyed at the new labor law, and some contemplate closing mines. The A. S. & R. Co. intended resuming at No. 3 smelter at Monterrey toward the end of January, but on account of the new regulations has decided not to start. The Minas Viejas and Villaldama calciner are working. The Paloma and Cabrillas Monterrey are shipping ore. The Providencia and Abbarradon Mazapil districts shipped several thousand tons last month.

SONORA

Increased activity is reported from several districts in this State, in spite of interferences. The well-known El Tigre, Cananea Consolidated, and Moctezuma companies are working regularly.

The CANADIAN MINING INSTITUTE will hold its 19th annual meeting at Toronto on March 7, 8, and 9. A number of interesting papers are to be read.

The short course for prospectors, miners and millmen, offered each year by the UNIVERSITY OF IDAHO at Moscow, continues until March 8. The work offered includes studies in chemistry, mineralogy, petrology, geology, prospecting, mining, assaying, ore dressing, and milling. E. K. Soper and R. R. Goodrich are the professors in charge of the work.

The LAKE SUPERIOR MINING INSTITUTE will assemble at Chicago on March 10, afterward leaving for Birmingham, Alabama, where the 21st annual meeting is to be held on March 13, 14, and 15. The invitation was extended the Institute through Edwin Ball, general manager of the Tennessee Coal & Iron Co., and C. T. Fairbairn, manager of the Republic Iron & Steel Co. Knoxville, Tennessee, will also be visited. A. J. Yungbluth is secretary at Ishpeming, Michigan.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

HOWARD D. SMITH is at New York.

C. D. KAEDING is at Mason, Nevada.

CHARLES C. RUEGER, of Butte, is visiting at Berkeley.

STUART CROASDALE, of Denver, called during the week.

ERNEST R. WOAKES has left London to go to South America.

H. E. CRAWFORD was here from Los Angeles during the week.

B. BRITTON GOTTSBERGER has returned from New York to Miami.

D. W. BRUNTON sailed on the *Ecuador* for Shanghai on February 12.

HUGH ROSE has opened an office at 487 Mills building, San Francisco.

ALBERT L. WATERS has gone to Kelvin, Arizona, for about four weeks.

FRANK E. MARINER, president of the Pensacola Tar & Turpentine Co., was in San Francisco during the week.

JAMES F. HOWARTH, of Wallace, Idaho, is at the Palace hotel, San Francisco.

J. F. MITCHELL-ROBERTS has returned from Denver and Globe to San Francisco.

E. A. STROUT, formerly superintendent of the La Fe mine in Zacatecas, is now at Los Angeles.

H. T. LIANG, of the Wah Chang M. & S. Co., is returning from New York to Changsha, China.

E. C. MORSE is watching tests being made by the Chino Copper Co., at Hurley, New Mexico.

A. A. COLE has been nominated by acclamation for the presidency of the Canadian Mining Institute for 1917.

JULIUS STIEGLITZ, of the University of Chicago, has been elected president of the American Chemical Society for 1917.

J. P. BICKELL of Toronto has been chosen president of the McIntyre-Porcupine Mines Co., of Porcupine, Ontario.

FORBES RICKARD passed through San Francisco on his way to the Atolia mines, in San Bernardino county, California.

HORACE V. WINCHELL, accompanied by IRA B. JORALEMON, sailed by the *Protecelaus* from Seattle, for Siberia, on February 16.

JAMES W. HUTCHINSON and EUGENE G. SNEDAKER, of the Goldfield Consolidated Mines Co., were in San Francisco during the week.

CHARLES H. DOOLITTLE has resigned as general manager for the Utah Metal & Tunnel Co. to devote all his time to his American Fork interests in Utah.

W. R. INGALLS has been appointed chairman of the committee of consulting engineers on mining law revision by the Director of the U. S. Bureau of Mines.

FRANK A. VESTAL, who has been superintendent of the cyanide plant at the Empire mine for several years, is now with the Grass Valley Consolidated Gold Mines Co.

ERNST TWITCHELL, of Cincinnati, has received the Perkin medal for 1917, from the New York section of the Society of Chemical Industry, for his research in applied chemistry.

The U. S. Civil Service Commission announces an open competitive examination for designing-mechanical engineers to fill a vacancy under the Board of Engineers, U. S. Army, at New York, at $2100 per year. The duties of this position are those of an expert designing mechanical engineer, familiar with structural steel and reinforced concrete, and will include the designing of mechanical equipment and material pertaining to permanent fortifications, heavy mobile armament, and armored railway trains. As insufficient eligibles were secured from the examination for this position of November 21, 1916, qualified persons are urged to apply. Applications must be filed by March 6.

THE METAL MARKET

METAL PRICES

San Francisco, February 13.

Antimony, cents per pound	24
Electrolytic copper, cents per pound	35
Pig lead, cents per pound	8.75—9.75
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$140
Spelter, cents per pound	12
Tin, cents per pound	48
Zinc-dust, cents per pound	18

ORE PRICES

San Francisco, February 13.

Antimony, 50% metal, per unit	$1.00
Chrome, 40% and over, f.o.b. cars California, per ton	18.00—20.00
Magnesite, crude, per ton	8.00—10.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO_3 per unit	17.50—18.00

New York, February 7.

Tungsten: Quotations are firm at $17 per unit. The market has been adversely affected by the uncertainty of international affairs, but yesterday (February 6) considerable business was done in immediate deliveries. Congested freight conditions cause spot sales to be favored, material which left the West in December not having yet arrived.

Molybdenite: The market is nominally $1.80 per lb. for 90% concentrate. If prompt supplies were available a good business could be done as foreign buyers are inquiring.

Antimony: Business has been done at $1.85 per unit.

EASTERN METAL MARKET

(By wire from New York.)

February 13.—Copper is strong and closely held. Lead is active, spot metal bringing premiums. Spelter is fairly active and firm.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Feb. 7	33.00	Jan. 2	29.90
" 8	33.50	" 9	28.20
" 9	34.00	" 16	28.33
" 10	34.50	" 23	29.34
" 11 Sunday		" 30	31.91
" 12 Holiday		Feb. 6	33.00
" 13	34.50	" 13	33.90

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	....	Aug.	17.27	27.03	....
Mch.	14.80	26.65	....	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

January copper production of important mines, in pounds, was as follows: Braden, 4,798,000; Kennecott, 7,080,000; Shannon, 759,000; East Butte, 1,479,520; Greene-Cananea, 5,790,000; Old Dominion, 3,000,000; Shattuck, 1,415,303; Cerro de Pasco, 6,152,000; Miami, 5,020,370; Inspiration, 11,600,000.

The total production of Miami in 1916 was 53,518,331 lb. of copper at a profit of $8,200,000.

The Champion company has declared a dividend of $6.40 per share, and the United Verde $1.50 per share.

Nine copper mining companies in January paid dividends aggregating $6,961,834.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Feb. 7	77.12	Jan. 2	75.37
" 8	77.25	" 9	75.28
" 9	77.37	" 16	74.66
" 10	77.37	" 23	75.87
" 11 Sunday		" 30	75.87
" 12 Holiday		Feb. 6	76.79
" 13	79.00	" 13	77.62

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	48.85	56.76	75.41	July	47.52	63.06	....
Feb.	48.45	56.74	....	Aug.	47.11	66.07	....
Mch.	50.61	57.89	....	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

The 'Times of India' says: "The absorption of nearly 400,000,000 rupees in twelve months (of which about 100,000,000 are estimated to have gone to Mesopotamia and East Africa) is without precedent in the financial history of India and is due to trade conditions since the middle of 1915. The people of India have been paid in crores for which produce has been going up in value and they retain these crores because they have not been able to buy freely imported articles like piece goods, iron and copper goods, bar silver and gold." (1 rupee = 30 cents.)

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Feb. 7	8.50	Jan. 2	7.49
" 8	8.50	" 9	7.50
" 9	8.50	" 16	7.50
" 10	8.75	" 23	7.72
" 11 Sunday		" 30	8.02
" 12 Holiday		Feb. 6	8.41
" 13	8.75	" 13	8.60

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	....	Aug.	4.67	6.28	....
Mch.	4.04	7.26	....	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Feb. 7	10.25	Jan. 2	9.75
" 8	10.37	" 9	9.66
" 9	10.50	" 16	9.37
" 10	10.75	" 23	10.00
" 11 Sunday		" 30	10.41
" 12 Holiday		Feb. 6	10.06
" 13	10.75	" 13	10.52

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	....	Aug.	14.17	9.03	....
Mch.	8.40	18.40	....	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

The New Jersey Zinc Co. reports its net income for the last quarter of 1916 at $8,197,051, of which dividends were paid amounting to $6,650,000. The total profit in 1916 was $33,200,000, and dividends paid $26,600,000.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Jan. 16	80.00	Jan. 30	85.00
" 23	80.00	Feb. 6	90.00
		" 13	140.00

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	....	Aug.	93.75	74.50	....
Mch.	78.00	219.00	....	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	....	Aug.	34.37	38.88	....
Mch.	48.76	50.50	....	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

ANTIMONY

Spot antimony is difficult to obtain, even at 25c., duty paid, the reason being the uncertainty of shipments from the West. In futures there is no business, the nominal quotations being 13 to 14c. in bond.

ALUMINUM

No. 1 virgin aluminum, 98 to 99% pure is strong at 57 to 59c. per pound.

PLATINUM

Price of platinum, New York is $105 per ounce for soft metal and $110 for hard.

Eastern Metal Market

New York, February 7.

International events have inspired a feeling that great caution is necessary on the part of all engaged in the metal trade. Everyone is waiting developments.

There is no copper market. The producers reiterate that they have no metal to sell for delivery before June and July, while second-hands are afraid to let go of their holdings. Quotations are therefore entirely nominal. Exports are almost at a standstill; meanwhile millions of pounds are accumulating at this port, the ultimate disposal of which can only be conjectured. If fed to the market lower prices undoubtedly will ensue.

Zinc is showing greater strength, but not much is doing, the producers being unwilling to sell except to satisfy the needs of actual consumers.

More than any other metal, lead is suffering from the congestion of railroad freight. For prompt metal, over 9c. has been paid. Great Britain has imposed on lead restrictions similar to those which cover copper.

Tin has again reached 55c., partly because consumers are building up reserves, and because of fear that shipments from the Far East may be interrupted. The possibility of shipping by way of the Pacific appears to be more or less overlooked.

Antimony is scarce and higher.

As was expected, because of the difficulty in securing deliveries of coke, the January production of pig-iron fell off, the production being 3,150,938 tons, against 3,178,647 tons in December. The daily rate was 101,643 tons, or about 900 tons less than in December. The total number of furnaces in blast on February 1, was 312, one more than on January 1.

Uncertainty over future shipments of ferro-manganese by England is a disturbing feature to the steel trade. Domestic makers have advanced prices to $250 per ton, a rise of $50.

COPPER

In keeping with the times, the situation in the copper market is unprecedented. Uncertainty fills the air and is responsible for a deadlock. Except for the occasional sale of a small lot, under circumstances which do not make the market, there is no activity, and prices are absolutely nominal. If a quotation for prompt delivery must be had, the best that can be done is to take the last quotation at which business was done—somewhere around 33c.—and call it the price. As a matter of fact, a leading metal journal which gives daily prices, temporarily dropped its table of quotations. Producers constantly reiterate that they have no metal to sell this side of June and July, and that for these months their price is 30 to 31c. It is unquestioned that second hands hold large quantities of copper, but they are afraid to let it go. A few exceptions come to light, of course, as in the case of a consumer who offered a small quantity, February 5, at 34.50c., cash. The export trade is practically at a standstill because no boats are sailing. Ships that might take the metal are behind their schedule in getting here. Of course, the Entente Allies will continue to get our copper, perhaps to a greater extent than heretofore, but temporarily there is a halt and in consequence copper is accumulating at the port of New York and elsewhere. The ultimate disposition of this metal is a natural subject of speculation. Millions of pounds are in New York awaiting export shipment, and while the movement to tidewater has lately been restricted by the railroads, more or less continues to come. Among the questions which the trade is vainly asking itself are these: Will the excess stocks awaiting export be thrown on the market? If war with Germany is declared will the metal be commandeered by the Government? Will the Government pay what the European nations have paid? If the Government does commandeer these accumulated stocks, will there be one price for the United States government and another for the private consumer? The only answer is that the people are in a fair way to learn what a full-fledged embargo means. Lake copper, though accounted by some a shade easier than electrolytic, cannot be had for prompt delivery. The exports, February 1 to 7, total only 4148 tons. Electrolytic at London is higher at £145. A week ago it was £143.

ZINC

The spelter situation also is dominated by fear of the war cloud. The producers are not anxious to sell, except to supply specific needs. They are particularly not desirous of stocking up jobbers or other second hands at present prices. On February 5, February delivery was easily obtainable at the equivalent of 9.50c., St. Louis (9.75c., New York), but early the following day, the market firmed up to 10 to 10.25c., St. Louis—10c. St. Louis, being paid for 200 tons of March delivery. With ore quoted, February 5, at $80 it is not surprising that the producers were not anxious to sell, for it meant that it cost about 9.50c. to produce the metal. On the afternoon of February 6 inquiry for several hundred tons of February to second quarter developed. At that time, brass-mill grades were quoted around 11c., delivered. In the past few weeks the extreme cold which has prevailed in the middle West has cut down production to a great extent through its curtailment of the natural-gas supply. There has been insufficient pressure to force the gas through the mains, and in some cases the availably supply was conserved for other purposes. The exports, February 1 to 7, totaled 1110 tons. The London quotation for spot was unchanged yesterday (February 6) at £47. Sheet zinc is unchanged at 21c., carload lots, f.o.b. mill, 8% off for cash.

LEAD

The congestion of freight on the railroads dominates the position of lead. The situation will be understood from the fact that lead that has been en route from the West for three months has yet to arrive in New York. Spot lead has been sold at prices ranging from 9 to 9.25c., New York. Prompt shipment and the usual 30-day delivery, are regarded as specialties. March delivery can be had at 8.50c., New York, and 8.30c., St. Louis. While it is true that an occasional carload gets through, it is not enough to relieve the situation. It is through increased arrivals, irregular as they may be, that the situation will be finally straightened out. In the West there is plenty of metal; the entire problem is in getting it East. For one recent arrival 9.50c. was quoted, a figure which proved unattractive to buyers. The exports February 1 to 7 were only two (2) tons.

TIN

The January statistics, showing that 7177 tons of tin was delivered into American consumption that month, was a bull influence on the market, and between January 31 and February 2, between 400 and 500 tons changed hands. It is believed that a large part of the deliveries mentioned were taken by consumers as a reserve in case Germany's submarine activity should seriously interfere with imports. Under the stimulus of the large buying, and the uncertainty of the future, quotations have advanced radically, the quotation yesterday for spot Straits being 55c. and for spot Banca, 52c. Fears as to future deliveries are held by many to be unfounded, as shipments can be made by way of Pacific ports without much likelihood of interference by submarines. But the tin market is always ultra-sensitive. The monthly statistics also show that the total world supply at the close of January was 18,169 tons, or 2568 tons less than at the close of December. There is afloat 4248 tons.

Mining Decisions

Coal Lease Not Taxable

A leasehold interest with the privilege of mining coal for a period of 19 years does not convey any title to the coal in place, and is not a taxable interest in real estate under the laws of Alabama.

State *v.* Roden Coal Co. (Ala.), 73 Southern, 5. Nov. 16.

Authority of Mining Corporation President

Authority to the president of a mining company to sell its mine for a certain price is not authority to employ another person to make the sale, in the absence of a showing that he was held out by the company as having general authority to make such employment.

Huey *v.* West Ossipee Mine Co. (New Hampshire) 99 Atlantic, 93. October 3, 1916.

Gas Leases Forfeiture Waived

An oil and gas lease not containing any provision that time was of the essence of the contract required the lessee to drill a well within 90 days. Six months elapsed of the one-year term of the lease, and then without notice to the lessee or claim of forfeiture the lessor executed a second lease. Thereupon the first lessee went into possession and put down a producing gas well. Held, on suit of the second lessee to oust the first one, that the failure of the lessor to insist promptly upon a forfeiture for failure to drill within the agreed time amounted to a waiver and the subsequent entry of the first lessee within the period fixed by his lease, and bona fide drilling operations established his right to continue for the term.

Bloom *v.* Rugh (Kansas), 160 Pacific, 1135. October 13.

Mineral Option: Development Work Unnecessary

An agreement called for a deed to an undivided interest in certain mineral and timber land and a 50-year option for the purchase of the remaining interest with the right, but not the express obligation of entering upon and exploring the property for mineral and timber. A cash consideration of $17,000 passed. Owing to the lack of transportation facilities for ore shipments the optionees made no attempt for 15 years to enter upon or mine the property. Held, on suit by successors in title of the optionors to have the option declared forfeit, that there was no obligation upon the optionees to enter and explore for mineral; that the consideration of $17,000 supported not only the land purchase but also the grant of the option on the remainder.

Mineral Land Investment Co. *v.* Bishop Iron Co., 159 Northwestern, 966. November 17, 1916.

Register's Certificate of Entry: Effect Of

The mere acceptance by the Register and Receiver of a local Land Office of the purchase price of a placer entry and the issuance of a Register's certificate, does not bar the United States during pendency of the matter in the General Land Office of the right to sue for cancellation and annulment of the interest of the applicant on the ground of fraudulent entry made in contravention of the oil-land withdrawal order of 1909. While the expiration of the period within which adverse claims might be filed would bar private applicants from contesting the entry, the Government itself is not thereby barred, nor is it necessary that contest by the Government be initiated in the Land Department where suitable grounds for intervention by a court of equity are set up in the complaint, such as fraud, necessity for receiver's appointment or other matters not within the Land Department's jurisdiction.

United States *v.* Devil's Den Consolidated Oil Co. (California), 236 Federal, 973. October 4, 1916.

Recent Publications

U. S. Bureau of Mines, Washington, D. C., 1916:

Prospecting and Mining of Copper Ore at Santa Rita, New Mexico. By D. F. Macdonald and Charles Enzian. Bulletin 107. P. 122. Ill., charts, index.

Operating Details of Gas Producers. By R. H. Fernald. Bulletin 109. P. 74. Index.

Molybdenum: Its Ores and Their Concentration. With a discussion of markets, prices, and uses. By F. W. Horton. Bulletin 111, mineral technology 15. P. 132. Ill., index.

Analyses of Coals. Coal purchased by the Government during the fiscal years 1908-1915. By G. S. Pope. Bulletin 119. P. 118. Index.

Principles and Practice of Sampling Metallurgical Materials. With special reference to the sampling of copper bullion. By Edward Keller. Bulletin 122. P. 102. Ill., plans, index.

Analytical Distillation of Petroleum. By W. F. Rittman and E. W. Dean. Bulletin 125, petroleum technology 34. P. 97. Ill., index.

Methods of Testing Natural Gas for Gasoline-Content. By G. A. Burrell and G. W. Jones. Technical paper 87, petroleum technology 21. P. 26. Illustrated.

The Radium-Uranium Ratio in Carnotites. By S. C. Lind and C. F. Whittemore. Technical paper 88, mineral technology 6. P. 28. Illustrated.

Suggested Safety Rules for Installing and Using Electrical Equipment in Bituminous Coal Mines. By H. H. Clark and C. M. Means. Technical paper 138. P. 32. Index.

Physical and Chemical Properties of Gasoline Sold Throughout the United States During 1915. By W. F. Rittman, W. A. Jacobs, and E. W. Dean. Technical paper 163, petroleum technology 38. P. 45. Charts, index.

Elementary First-Aid for the Miner. By W. A. Lynott and D. Harrington. Miners' circular 23. P. 22. Illustrated.

Mineral Production of Canada in 1915. By John McLeish. P. 45. Department of Mines, Ottawa, 1916.

Summary Report of Mines Branch of Department of Mines of Canada for 1915. P. 213. Ill., charts, index. Ottawa, 1916.

Book Review

Elementary Cams. By Franklin DeRonde Furman. P. 90. Ill., index. John Wiley & Sons, New York, 1916. For sale by the Mining and Scientific Press. Price, $1.25.

In the preface the author says, "This book has been prepared with a view to gathering the various types of cams that are in common use . . ." Naturally we looked for something on stamp-mill cams, of which there must be at least 30,000 in daily operation in the many mining centres of the world—including 6000 in the United States—but we found no mention of this important cam, upon which so much study in design and metal has been given. From this point of view we are disappointed with the work, and it is difficult to see how the author overlooked stamp-mill cams. A cam is a peculiar piece of mechanism. Its shape may be described as the involute of a circle, slightly modified at the end so as to retard gradually any desired motion. The design of cams involves many problems, and in this book they will be found discussed. Cams are used in most machinery, ranging from those operating valves in automobiles, the intricate gear in a linotype, valves on a steam-engine, gear on machine-tools, and the heavy double-arm cam lifting gravity stamps for crushing gold and silver ores. Mechanics will find this book of value.

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Edited by T. A. RICKARD

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MASSCO

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MARCY BALL MILL

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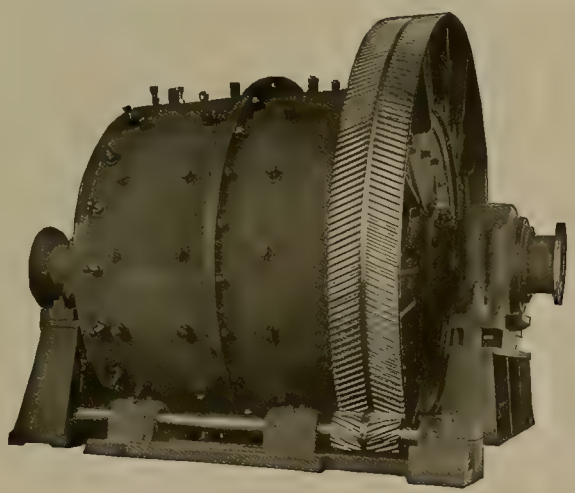

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The Real Discoverer of the Oil-Flotation Process
The Granby Company's Mines in British Columbia

PITTSBURGH COAL PRODUCTS COMPANY
PITTSBURGH, PA.

MAIN OFFICE AND WORKS
MONACA, PA.

November 29, 1916.

Oliver Continuous Filter Co.,
Market Street at First,
San Francisco, Cal.,

Gentlemen:-

This will confirm our telegram of to-day which reads as follows:-

"Filter delivered yesterday twenty-eighth. Many thanks for prompt shipment."

We feel that we are under obligation to yourselves and the Express Company for your most prompt action in handling this shipment. It hardly seems possible that a piece of equipment of this nature could be ordered on the 20th of the month at San Francisco, and delivered to us at Pittsburgh on the 28th of the same month. We are arranging to complete the installation as readily as possible, and will certainly avail ourselves of your further assistance as we may require the same.

We also acknowledge receipt of your letter of November 24th, enclosing invoice, packing list, and copy of operating instructions. These will have due attention. Again assuring you of our thanks for your cooperation in this matter, We are,

Yours very truly,

PITTSBURGH COAL PRODUCTS COMPANY,

Treasurer.

JGB/w

THESE TWO LETTERS TELL THE TALE

PITTSBURGH COAL PRODUCTS COMPANY
PITTSBURGH, PA.

UNLESS OTHERWISE INSTRUCTED ADDRESS ALL COMMUNICATIONS TO THE COMPANY AT MONACA, PA.

BELL TELEPHONE ROCHESTER 65 BEAVER VALLEY

MAIN OFFICE AND WORKS
MONACA, PA.

ALL AGREEMENTS ARE CONTINGENT UPON STRIKES, ACCIDENTS, AND OTHER DELAYS BEYOND OUR CONTROL.

January 10, 1917

Oliver Continuous Filter Co.,
403-Market Street,
San Francisco, Cal.,

Gentlemen:-

In pursuance to our correspondence at the time of the purchase of one 6x6-25 ton Oliver Continuous Filter, we beg to advise that we have now had this equipment in satisfactory service since about the middle of December. We are most gratified with the results obtained, both in labor saving and in increased efficiency.

Prior to the installation of this machine, we were losing from 30% to 36% Sodium Benzene Sulphonate in press-cake, and in addition to that, we were greatly handicaped by having insoluble Sulphates retained in our mother liquor. The loss in press-cake is now reduced to from 6% to 8% and will be still more out down, we believe, as our men more thoroughly master the use of the machine. The objectionable Sulphates are almost entirely eliminated.

As befor stated we are much pleased with the results obtained and we do not hesitate to say that the purchase of this equipment is one of the best investments we have made.

Yours very truly,

PITTSBURGH COAL PRODUCTS COMPANY,

Treasurer.

JGB:w

Oliver Continuous Filter Co.

501 MARKET ST. SAN FRANCISCO, CAL.

EDITORIAL STAFF:
T. A. RICKARD - - Editor
M. W. von BERNEWITZ
W. H. STORMS
Ass't Editors

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E. H. LESLIE
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Science has no enemy save the ignorant

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UNION CONSTRUCTION COMPANY

The Union Construction Page

UNION CONSTRUCTION COMPANY

TO MINERS
of
PLACER GOLD

Investigate the Union Drill. It is easy to operate; it is readily portable and can be knocked down for mule-back transportation and easily re-assembled. It is made in two types, A and B, the latter with steel frame and design for somewhat heavier work than A. The illustration below shows the Type B drill ready for operation. Bulletin 15 gives much interesting data of value to prospectors and placer miners in general. Write for it.

This is one of many gold dredges designed and constructed by this company. It was built for C. J. Berry and has a 3½-foot bucket line, and digs from 1700 to 2400 cubic yards per day of 24 hours. We contract for the design and construction of gold dredges for any capacity, to be erected anywhere. This dredge is operated on wood fuel, using only $3\frac{4}{10}$ cords per day of 24 hours.

Union Construction Company

H. G. PEAKE W. W. JOHNSON

604 Mission St.
San Francisco

The Neill jig is being used with great success on dredging and sluicing operations for the saving of fine and rusty gold. If you are operating a placer mine, it is worth money to you. Write us.

EDITORIAL

T. A. RICKARD, Editor

THAT oil may be discarded eventually in flotation work is suggested by the success of the Freeman process at Broken Hill.

RHODESIA'S output of gold last year was worth £3,895,311 or $18,892,258, this being £72,145 or $349,903 more than in 1915. The largest producer is the Shamva, which contributed £36,054 from 51,360 tons in December.

CANADIAN consumption of cyanide is estimated at 1500 tons per annum, or slightly less than the quantity used for fumigation in the orange-groves of California. Ontario consumes 120 tons per month and British Columbia 8 tons per month.

THE nineteenth annual meeting of the Canadian Mining Institute is to be held at Montreal during the three days beginning on March 7. Mr. Arthur A. Cole has been re-nominated for the presidency by acclamation. A promising list of papers is announced.

COTTRELL patents for Japan have been acquired recently by a syndicate composed of the Ashio Copper, Furukawa, Sumitomo, and Kuhara companies. We are informed that $150,000 in cash was paid to the Western Precipitation Company for the use of these patents both in metallurgical and industrial plants.

SOME thoroughly bad work is being done in flotation in mills that we do not care to mention. This failure is due largely to lack of experience and the inability to ascertain the modification most suitable to a particular ore. In many cases the flotation practice is compelled to adapt itself to a pre-existing flow-sheet, which may be defective, particularly in the grinding department.

BRITISH efforts to obtain sufficient tungsten and to control a sure supply for the future have led to the formation of an organization called High Speed Steel Alloys, Ltd. This is composed of 31 of the biggest manufacturers of steel in Great Britain. The company has taken steps to secure the Burmese and Malayan output of tungsten. An office has been established at Tavoy, in Burma, where a large laboratory is now serving to investigate the supply of wolfram and other tungstates obtainable in the Malayan peninsula and its hinterland. Meanwhile our domestic price of tungsten remains fairly strong and steady, the production having become less feverish. Some sort of regulation of the tungsten output from California, Nevada, Arizona, and Colorado is likely to be effected, so that the mines will not be wholly at the mercy of the steel-manufacturers.

NOTICE is reported to have been given by the Mexican government that mining properties not operated for two months, and controlled by owners that have not made application for an extension of the time-limit within which the properties had to be started to work, will be seized by the Government. It is also rumored that Villa has gone to Japan. These items of news, like others from the southern side of the Rio Grande, are 'important if true.' Meanwhile the United States is again represented diplomatically at Mexico City, Mr. Henry P. Fletcher having reached his new post.

A FRENCH-CANADIAN prospector writes to a friend of ours concerning a new theory of ore deposition, whereby "iron was made by the sedition of water." He quotes several "authorities way up in the profession," more particularly a certain T. A. Rickard, who is described as State Geologist of Colorado, and is said to have delivered an address before a meeting of geologists at Buffalo, in October 1898, in which he said: "Mineral has come to surface by volcanic eruption, erosion, and overflow of the lava." To which our prospector adds: "The school of France says it short *'la fusion'.*" So is a man's reputation stolen from him. 'Tis a sad world.

DESPATCHES from Belgium, and a telegram from Mr. Hoover himself to the San Francisco representatives of the Belgium Relief Commission, indicate that the good work is still proceeding and that it will proceed. The orders given by the German officials compelling the American Relief workers to get out of Belgium have been rescinded, so that they can remain at their posts under the conditions existing before the break in diplomatic relations between Washington and Berlin. Sufficient reserves of food are stored in Belgium to allay any fear of immediate famine pending the arrival of further shipments, which are now again on the move. Mr. Hoover desires all sympathizers with the good work to know that further financial support may be sent without the fear that it will prove ineffective. Send your subscription for the children to Belgian Kiddies, Ltd., 120 Broadway, New York.

OPTIMISM is a good quality in mining; without it the industry would soon become senile; but too much of it is intoxicating. In an Idaho paper we read about the 'New Demming Gold Fields' and this is how the

article starts: "The rain had fallen throughout the first day of my examination. Just at sunset the clouds broke and my friend said, 'Look at the wonderful rainbow.' I said, 'Yes, and this is the end of it.' 'Do you think so?' he asked. 'Yes,' I replied, the 'dream of the mining geologist is fulfilled.'" This rhapsodical fragment is worthy of a better cause. The dream includes "ores that harken back to the Archean" and invade Tertiary rocks. Gravel covers the ridges. "The eschar of these gravels prove to a strong extent the product of a thermal (aqueous) crater area and have no significance with the later impounded fresh waters." Thus the dream passes into a nightmare of pseudo-scientific jargon and the rainbow hues of the poet fade into the murk of turgid writing.

MINING on the Indian reservations is the subject of a bill now before Congress. It has been passed in the House and has been reported favorably by the Committee on Indian Affairs. Over 30,000,000 acres of land remains unallotted on the Indian reservations and large tracts within this acreage are known to be mineral-bearing. The American aborigines do not engage in mining, having neither the skill nor the capital required. These lands, however, are the tribal property of the Indians and for that reason it has not been the policy of the Government to permit mining on the reservations. They have been set aside for the exclusive use and benefit of the Indians, who are entitled to receive an income from such property, if leased. It is proposed to exploit the mineral land under a leasing system. In Arizona alone 19,551,045 acres is unallotted, not including the new Papago reservation, on which the mineral land has not been withdrawn from entry. Mr. Will L. Clark, of Jerome, has taken the matter in hand and is co-operating with Arizona's representatives in Congress.

DISCUSSION this week starts with the remarkable letter from Mr. Hedley D. Crowder, proving the part played by his father in the origination of the Elmore bulk-oil flotation process. We discuss the matter on another page. Next comes a letter from an old friend in Australia, a mine manager that chooses to hide his identity under a literary pseudonym. He makes a plea in behalf of Charles V. Potter. We second his plea, for the record shows that the first mill unquestionably successful with the flotation process was the one that used Potter's method on the Block 14 mine at Broken Hill in 1903. The Potter-Delprat process scored the first commercial success, for the Elmore bulk-oil method won no permanent foot-hold in metallurgy, while the Broken Hill Proprietary mine is still using the Potter process on a large scale, as modified by Mr. Delprat, the manager of that mine. Mr. Loring Hanson, who is engaged in mining at Adelaide, in Humboldt county, Nevada, records sundry observations on seismic unrest. We do not wonder that he and his friends feel uncomfortable, but, as far as the evidence goes, they need not fear to go underground. That is safer—during an earthquake—than the surface. Mr. Edwin Higgins, recently with the U. S. Bureau of Mines as an Inspector, gives his testimony concerning the best way of preventing misfires, replying to Mr. Brooks. Mr. Fred. G. Tyrrel throws some light on the difficulties inherent in the sampling of small lots of ore, controverting sundry statements made by the contributor that signed himself 'Lovejoys.' The subject is one to interest many of our readers and we look for further contributions to this discussion.

AUSTRALIAN mining affairs are interesting to such of our readers as have a wide mental horizon. For that reason we draw their attention to the long letter appearing last week from our Melbourne correspondent. He deals with the metal trade and the upset that followed the incidence of war. The adviser that the Australian premier, Mr. W. M. Hughes, had at his elbow is said to have been Mr. A. H. Higgins, of Chillagoe fame, but we have reason to believe that Mr. W. S. Robinson was consulted frequently by the Premier. In their effort to break an international or non-national cartel of metal merchants the Australians have swung to the other extreme of commercial parochialism. It is too violent and narrow-minded to last. Business finds the cheapest market as surely as water flows downhill. Our correspondent gives a number of interesting details concerning the zinc industry of Broken Hill. The outlook for mining—especially mining for gold—in Australia is not good. Several famous mining districts are approaching exhaustion and the domination of the Labor party appears to have unduly harrassed the operators of mines.

The Presidency of the Institute

We learn by telegraph that Mr. Philip Moore has been elected president of the Institute after a close contest. Over 2000 votes were cast. This number, out of a membership of 5000, indicates that great interest was taken in the election—which is a good sign, for interest is closely akin to loyalty. Mr. Moore will make an excellent president, and so will his competitor, Mr. Sidney Jennings. We suggest that Mr. Jennings be placed in nomination forthwith and elected unanimously next year. Thus we can gain the benefit of the interest aroused without any of the permanent harm. If this is not done, we shall see a campaign even more unpleasant in some respects than the one just ended, perpetuating the cleavage between the 'stand-patters' and the reformers. That will do no good and it may contain the possibilities of much harm. The idea that a coterie in New York selects the president irritates many Western members, even if the idea lack sound foundation; so also the suggestion that the big mining corporations exert a preponderating influence on the directorate. Such notions can be cured by changing the methods of selection. Why not have a Nominations Committee composed of all the chairmen of the local sections together with the President and the two Vice-Presidents of the Institute *ex officio*? Then invite nominations for the presidency and vice-presidencies, and

ask members to submit their views frankly to the committee, which would thus be well fortified to act, avoiding the unpleasant kind of campaign to which we have been treated recently, and yet ascertaining the desires of the general membership. Men of the highest type will not be willing—they will refuse—to enter a personal contest for such an honor as the presidency. If we are to have these unseemly competitions we must make up our minds to forego the presidential service of some of the best men in the profession. The old way of running the Institute like a close corporation was objectionable, as we know now, but the new scheme of a campaign of vote-solicitation is equally objectionable. If we must have campaigns to awaken the Institute periodically let it be through the election of directors. By all means let the Nominations Committee give us a choice of directors, by nominating at least twice the number required. That will afford occasion for ventilating our opinions on matters of policy and organization, and for selecting those whom we wish to act as trustees for us. We shall be glad to publish expressions of opinion on this subject.

Crowder-Elmore—Flotation

In our issue of September 23 we published an appeal made to the profession by Mr. A. Stanley Elmore, in behalf of himself and his brother Mr. Francis E. Elmore, setting forth their claims to the original discovery of the flotation process, and reciting the shabby treatment to which they were subjected by the Minerals Separation people, notably Messrs. Ballot, Sulman, and Picard. We commented in friendly fashion on this *argumentum ad hominem* and expressed our belief that the service done by the Elmore brothers to the development of flotation, by their mechanical ingenuity and by their persistent publicity of the process, had not been adequately recognized. We hold to that belief still. In the course of his recital Mr. Stanley Elmore claimed that his brother Frank had been led to his invention of the flotation process by observing the accidental concentration of chalcopyrite in the oil that had dripped upon a launder from a shaft-bearing, and also by remarking the fine particles of mineral collected at a spot where a greasy hand had been laid upon an iron pipe. In commenting on this Newton-like story, we stated that we had always been under the impression that the Elmores obtained the idea of oil-concentration through the fact that experiments in the use of oil for concentrating ore had been made previously at the Glasdir, the Welsh mine where George Robson and Samuel Crowder had preceded the Elmores in an effort to treat a low-grade copper-bearing gold ore. We supposed that Mr. Frank Elmore must have been aware of the previous work done on the same spot and must have seen some of the discarded apparatus left by his engineering predecessors. To this Mr. Stanley Elmore replied in our issue of November 18, 1916, stating that there was "not a word of truth" in our supposition, "not a shadow of justification for any one of the suggestions or innuendoes or whatever they may be." He followed this by a particular denial of the use of Robson's machine, and an explanation that all of the Robson & Crowder plant had been removed before he and his brother arrived at the Glasdir mine. He underlined the assertion that "Frank Elmore has not at any time even seen a Robson & Crowder machine" and mentioned a letter from Crowder in which the Elmores were congratulated upon their success "made where he and Robson had only encountered failure; and in which he compliments us [the Elmores] on having discovered the one thing essential to success which had always eluded them [Robson and Crowder]." In commenting on this editorially in the same issue we said that Mr. Stanley Elmore placed too much emphasis on the Robson & Crowder "machine." We had not used the word 'machine,' but had written concerning "remains of Robson's experimentation, in the form of oil, pulp, and apparatus." We suggested then that "it would be worth while for Mr. Frank Elmore himself to publish an explicit denial and so kill the story conclusively." In saying so, we had nothing up our sleeve, but we did consider it remarkable that the two Elmores could go to the Glasdir mine without hearing about the experiments made on the same spot by Robson and Crowder or without seeing some remnants of such work, either in the form of apparatus or of oily discard. In due course we received a polite response from Mr. Elmore stating that he had no more to say. Between the date of our suggestion and his reply we received a letter from El Oro, Mexico, stating that the writer of it was the son of Mr. Samuel Crowder, who was still alive, but very old and feeble, yet in full possession of his mind and also in possession of a diary recording the events under discussion. The son, Mr. Hedley D. Crowder, asked to be allowed to defend his father's claims to credit in the invention of the flotation process, and we replied, of course, that he would be given an opportunity to state his case. That is how we come to publish the clear statement appearing on another page. We publish it with no sort of satisfaction, but with deep regret and as a plain matter of justice to all concerned. Mr. Hedley Crowder proves that the statements made by the Elmore brothers are highly disingenuous. The letter of Mr. Samuel Crowder of December 10, 1897, is convincing, unless Mr. Elmore can produce fresh evidence in rebuttal. The first Elmore patent for the bulk-oil process was taken out on October 18, 1898. Mr. Crowder asserts that the Robson plant was on the property when it was taken over by the late William Elmore, the father of the two patentees, in 1896. Mr. Crowder's notes, of 1897, show much practical sense. It is a curious fact that mill-men knew long ago that grease or oil aided the escape of gold from the stamp-battery and that the use of too much cyanide, for brightening the amalgamating plates, was attended with loss, but in neither case did they investigate closely; if they had, they might have lit on the principles underlying flotation on the one hand and of cyanidation on the other. Even the 'flouring' of quicksilver and the 'sickening' due to oil did not explain

the deleterious effect of grease. We know now that the greasing of a globule of mercury will cause bubbles of air to attach themselves in such a way as to buoy the heavy metal to the surface of the water. Mr. Crowder's suggestion of one pound of oil per hundredweight of ore comes very near to the famous "less than 1%," for the British 'hundredweight' contains 112 pounds. In his later letter, of 1899, he claims that the Robson process recovered 98 to 99% of the "metal," meaning gold, silver, and copper, but the experiments did not determine "the cost of manipulation." Of course, Mr. Francis Elmore's main contribution to the art was the mechanical ingenuity by aid of which he devised several effective machines both in the bulk-oil and in the later vacuum-oil method—the belated recognition of air itself as a prime factor in the process of levitation. Mr. Crowder's letter of 1901, quoted by his son in full, affords a pathetic commentary on Mr. Stanley Elmore's insistent claim for originality in the use of oil for concentration by his brother and himself. No wonder Mr. C. M. Rolker in 1900 called the process a "somewhat dirty and nasty" one. The whole history of it is full of unpleasantness. Our own belief is that inventiveness has played a minor part throughout and that the advancement of this metallurgic art has been due largely to manipulation, which is not patentable and has improved gradually, almost unconsciously. Given the idea of the flotative effect of oil, whether first suggested by Herodotus or Everson, or Jonah, it is possible by means of skillful manipulation to produce most of the results achieved today.

Water in the Desert

The necessity for placing more sign-boards and otherwise indicating the watering-places in the desert is receiving the renewed attention of many that are interested in the development of the resources of the Great Basin and of the dry tracts of southern California. The dangers of travel in arid regions are now well understood by those long accustomed to them, but in earlier years the lives of many travelers were lost through ignorance. All of the unfortunates were by no means inexperienced in the rough life of the West, or even of the desert, for among them were some that had spent years in the mining districts of the Mojave and the Colorado deserts, but apparently they had found themselves unexpectedly without water, and being unable to reach a place where it could be obtained, they perished. As the desert region became better known, it was learned that springs were far more numerous than had been supposed. Frequently the direction of these springs or water-holes from the main routes of travel was indicated by stones placed at the side of the road. Such signs usually were made of two rocks, one of which was set upright, and the other placed on top of it, with its longer axis pointing toward the spring. Many of these stone water-guides had been placed by Indians, and were observed and appreciated by most of the earlier travelers. Others, not familiar with Indian signs, and not realizing their significance, kicked them over carelessly, and thus did a stupid disservice to later comers.

Several years ago an active and successful campaign was started in California to secure State aid in placing iron guide-posts along the desert roads. The Legislature made an appropriation for this purpose, and a number of public-spirited men gave valuable personal aid in the way of information, and also in setting up these guide-posts where they would be of greatest help. Generally they were placed at the forks of roads, or, in the case of water-signs, at the side of the road nearest a spring or water-hole that might be some distance from the road. On these guides were the names of towns and their distance, or they pointed to the nearest place that water could be obtained. Without doubt, they have contributed much to the convenience as well as to the safety of travelers through the desert regions. The United States Geological Survey aided the cause by the publication, in 1909, of Water Supply Paper No. 224, by W. C. Mendenhall, entitled, 'Some Desert Watering-Places in South-Eastern California and South-Western Nevada.' It contained a description of the position and character of a large number of springs on the desert. Unfortunately this book is no longer obtainable, the edition long since having been exhausted. Subsequently the Survey extended its work over the arid region of the South-West, and covered a good part of Arizona, New Mexico, and Utah, as well as Nevada and southern California, but much still remains to be done in the way of indicating the places where water may be obtained. Not only are maps needed but sign-posts, to be placed along the main roads and trails.

While it is true that springs and water-holes are much more numerous on the desert than is generally supposed, many of them are obscure and it is easy for a traveler to pass within a few yards of a spring and fail to be aware of it. Old Woman's spring, 45 miles east of Victorville, on the Mojave desert, flows several inches of water, yet a person might easily pass on the west close to it and never suspect that water was near. The spring issues from beneath a cliff of basalt that extends for a mile or more. In the Colorado desert there is a little water-hole about 11 miles north-east of Mecca. This spring is in the bottom of a gulch among rugged, but not high, hills of sandstone and shale. It is about 3500 ft. from the road, running through Box canyon from the railroad to Cottonwood spring. One of the Indian stone guide-posts marked it for the traveler years ago, but even when one knew of the existence of this water-hole it required care to find it, and the searcher came within 15 feet of the water before it could be seen. It was only a small spring with little or no water flowing, still it was sufficient to save human life, or even to succor a team of horses in an emergency. These two instances are examples of many such watering-places the whereabouts of which are not generally known. An effort is being made to secure an appropriation from Congress to develop and protect these watering-places of the desert, and to make their position known by means of metal guide-posts. We hope the effort will be successful.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Crowder-Elmore—Flotation

The Editor:

Sir—I am making what is undoubtedly a belated entrance into the discussion that has now been in progress for some months, as to who did, or did not, discover the oil process of concentration, now known as the 'flotation' process.

I have always considered my father, Samuel Crowder, and George Robson as the originators of the method of separating sulphides from crushed ores by the use of oil. Imagine therefore my surprise at reading A. S. Elmore's article entitled 'Notes on the Invention, Development and Introduction of the Flotation Process,' and the various articles based on it that have appeared in the technical press—their general tenor being to the effect that the Crowder-Robson patents and machine were never seen by the Elmores and that the work of the former was unknown to them.

Robson has been dead for many years, but Samuel Crowder, now well over eighty years of age, is still living, though in too delicate a state of health to allow of his entering the arena in his own defence. It so happens that, being a man of methodical habits, he has kept a diary during the greater part of his life. This diary is particularly complete covering the period in which he was working out the oil process.

As my father is resident in England it has taken me considerable time to receive from him the necessary data to present the Crowder-Robson case, more especially owing to the present disorganized state of the postal system.

Their case is best given in my father's own words:

"In the interest of historical truth, and the protection of Robson's reputation, I am sending you these particulars. At the start, however, please clearly understand that I do not wish to detract from Mr. Elmore's valuable developments of the invention.

"The fact is that for many years now, I have given up all interest in the process, and it was not until I saw the article from the Mining and Scientific Press of September 23, 1916, that it occurred to me that I ought to put a few facts on record as to the origin of the process.

"On the 18th of May 1892 I bought the Glasdir mine in Wales and in the same year I engaged George Robson as the manager. I may say in passing that the ore in the mine is of a very interesting and very deceptive character. After working for several years I found that the gold was in the condition of 'float' and that it could not be caught by water. Finding that it was quite impossible to concentrate the ore, as I was trying to do, by water, I gave up working it, keeping Mr. Robson in my employ, and leaving him to fossick about and see if he could make any improvement in the method of concentration.

"For this purpose he tried paraffine, turpentine, and other things, and finally oil. He wrote to me that he believed he had found a method of concentration, and I at once fitted up a laboratory in the City and carried out exhaustive experiments, obtaining an extraction of 90% in some cases. We carried on experiments at the mine and erected an experimental plant.

"On April 15, 1896, I sold the mine to William Elmore, Sr., father of Frank Elmore, for the sum of £15,000, and when leaving his office I asked him how he intended to concentrate the ore. He said he had a plan, to which I replied: 'You will never concentrate that ore with water; *you can do it with oil* as our experiments have shown.' He treated the matter lightly and said that he was quite prepared for the difficulties.

"So the matter went on and he took possession of the mine. He very soon discovered that he could not concentrate the mineral with water. *My oil plant being still erected on the property*, I advised him not to pull it down at first, but to try and see whether it could be made effective.

"Later it came to my knowledge that Frank Elmore had claimed a patent for the use of oil in the concentration of mineral, on which I wrote the letter of March 18, 1901.

"Finding that Mr. Elmore could not carry on and had fallen on evil days, I wrote to him, and as an expression of sympathy returned him bills which were coming due, amounting to £2000.

"From the above it will be seen that Mr. Robson was the real discoverer, but that I took the matter over and paid all the costs and charges of working the mine and of Robson's experiments and patents.

"The discovery was made, as so many are, by accident. As already said, Mr. Robson was left in charge of the mine with instructions to see if he could improve upon the process we had been using. By accident he picked up a can of oil, and as he said, almost absentmindedly tried to concentrate some of the ore.

"The result was extraordinary and I spent a lot of money trying to develop the idea.

"This is the true genesis of the oil process.

"The original letters and papers are all in my possession."

I will now give some extracts from original correspondence proving that for some time after the Robson patent had been taken out, in 1894, my father continued to think over the oil process, and evolved ideas that must have been at least suggestive to anyone engaged in experimental work on the same process.

Under date of December 10, 1897, he sent a communication to A. S. Elmore in the form of notes, partly covering his ideas of the mode of occurrence of the gold and silver in the ore, and partly dealing with his ideas of how these values could be recovered from the ore by the use of oil.

The following are his notes dealing with the use of oil:

"10. Now respecting the use of oil for concentration. Of course, to anyone who has not seen the effect, it appears an absurdity and against natural law; be it so; the fact remains that the ore can be concentrated and all the metal saved by the use of oil.

"11. The action of oil with gold and sulphuret ores finely ground is so extraordinary that it must be seen to be appreciated—Query—we know that a very small quantity of oil in a battery-box will cause the loss of all the gold running over plates. The received theory is that it 'sickens' the mercury and prevents amalgamation —probably it does—but from what I have seen, I believe it picks out the gold and carries it away.

"12. Now, the experiment I want to see tried is this: Mix common petroleum with about 5% of any coarse oil and use a jet on the vanner, or rather the oil should be mixed with the wet slimes settled in the pits before it goes on the vanner. I cannot tell what quantity of oil would be required per cwt. of ore, but whatever it was, it could be saved by running it into a tank.

"Try it, and I think you will save your metal from the slimes. Try an exhaustive and fair experiment of one pound of oil mixed with 1 cwt. of slimes and gradually increase if required.

"13. Hurst's Company no doubt made a mistake when they refused to make a trial of the oil process at the time when the machinery was all fixed up in working order upon the mine and the trial could have been made without cost. I hesitate to suggest that the plant should be again erected, but it is the only process I have found to recover all the mineral contents.

"14. I feel sure that all the mineral can be recovered from the slimes by the plan suggested in No. 12, or some modification of it."

A year and a half later—to be exact, on July 28, 1899 —my father, hearing from A. S. Elmore that they were not making a success of water concentration at Glasdir, sent him some further notes, substantially similar to those already referred to. I regret that considerations of space prevent my giving them *in toto*.

"As you [A. S. Elmore] are aware, the problem of working the Mawddach ore at a profit has been to me a most interesting study, and one that has a kind of fascination for me, as I feel and have always felt that there must be some method by which all, or practically all, the metals should be saved.

"From what you told me, I understand you are not saving as large a percentage as you could wish.

"During the years the place belonged to me, the subject was, of course, an ever-present one to my mind, and many schemes and methods were considered and abandoned, *until we hit upon the oil process, which was in course of trial when you bought the mine*; undoubtedly that was a success so far as saving the metal was concerned, as 98% to 99% was recovered, the only question being the cost of manipulation. I am of opinion that this could have been reduced to a small amount, but the experiments were not carried far enough.

"The following notes are from my journal while working and the results of cogitation since, whether they are of any value I leave you to judge, probably you know more about the matter than I do, and have better plans for working than I could suggest, *but I think the idea of using oil, as proposed, is new,* whether it is practicable is quite another matter.

"The question is, would the introduction of oil into the launder feeding the vanner 'wet' the 'float' and carry it to a definite division? The question can only be determined by experiment; *the assumption is that a very small quantity of oil would be sufficient,* and that it would be afterwards nearly all recovered.

"In my humble opinion here are three most striking suggestions.

" '1. The use of a mixture of a heavy and of a light oil.

" '2. Selective action in the presence of a large quantity of water.

" '3. The use of small quantities of oil, namely 1% of the weight of the dry ore.' "

A year and a half later, early in 1901, the Ore Concentrating Syndicate issued a pamphlet on 'Elmore's Process.'

On receiving a copy of this, my father wrote to William Elmore the letter already referred to, of March 18, 1901, which I give in full as closing the Crowder-Robson case.

"W. Elmore, Esq:

"Dear Sir—I received a pamphlet from the Ore Concentrating Syndicate on *Elmore's Process.*

"I must say I do not think that your son has acted fairly to Robson, or indeed to me; so far as I am concerned it does not matter, I am only too glad to find that you have at last tried the oil process, and found it to be a success.

"You will remember (as I have previously reminded you) I told you before you had spent 1s. 0d. on machinery that you could not concentrate that ore with water and I also offered you free of cost the use of the oil concentrating plant *that your son saw* and that was at the time erected on the mine and which had done successful

work; your reply was 'please remove it as soon as possible.'

"On Dec. 10th, 1897, when I found that you were convinced that you had failed with the vanners and water, I wrote to your son the enclosed letter. Two years later, Jan. 1899, I heard that you were using oil, and had taken out a patent; *it is about as cool a piece of business as ever I heard of.*

"So far as I am personally concerned, I want no acknowledgement, but that your son should ignore Robson is not right; we spent about £2000 over the business and took out patents all over the world, France, Germany, the United States, Mexico, and all the Colonies.

"I am glad that you have at last adopted the method, and only regret that you did not do so when I first advised you.

"The first paragraph of the pamphlet struck me as being almost comical, as it is nearly verbatim the same that I wrote 5 or 6 years ago when bringing out our prospectus.

"I see your vanners only recovered 14.5%, less than half of what I obtained with jigs and buddles (on page 3). You can scarcely call it a '*novel process*' when you saw our plant erected on the mine when you bought it 5 years ago.

"On comparing your results from the oil, I find they are about the same as we obtained.

"Yours truly,

"S. CROWDER."

I enclose, Sir, copies of the original documents referred to. Possibly you will not be able to find space in your valuable paper for this necessarily long statement, but I feel assured, in any case, that with your well-known impartiality and desire for accuracy, you will sum up the evidence you now have before you in such a way that the true history of the flotation process will be known to the metallurgical world.

HEDLEY DAWN CROWDER.

El Oro, Mexico, January 27.

Patents and Successful Flotation

The Editor:

Sir—To the ordinary man the flotation controversy is becoming more thoroughly mixed than even the best practice of the art enjoins. Incidentally, it must be bringing to most of your readers the question to which you invited discussion with so little response some time ago, as to whether patents are worth while to anybody but lawyers.

I am one of those that believe there should be no patents, and that were there none the real inventor would receive a better reward for his invention than he does now. If there were no patent rights, invention would be just as prolific as now, but the inventor would have to trust to the honor of users for his reward, and I believe he would not be disappointed. In a well-known instance—the invention of the Glover tower, where honor was relied on—I believe the inventor's claims were always recognized by honorable payment. Certain it is that the reward of valuable invention, under the present system, seldom reaches the real inventor, and it is obvious that such is going to be the case with flotation. But, *revenons à nos moutons*, are we not being muddled by the legal warfare into making puzzling a very simple matter? I recollect listening many years ago to a commencement address by a certain Senator to the students of a college in one of your central States, upon the subject 'Success,' in which, referring to great inventors and the anticipators, who were always raked up to decry their merits, he declared that the real inventor was the man who invented a thing so that "it kept invented." I think most of us will agree with the Senator.

Now, Sir, in your editorials and in most of the correspondence, the name of the inventor who 'kept' flotation 'invented' has been omitted. All are agreed as to where it was first "kept invented;" that is, at Broken Hill. Now, who kept it invented there? Most Australian onlookers think of one man only, namely, Potter; but there can be no doubt about the answer if two names are included, namely, Elmore and Potter; they are the men who invented flotation and kept it invented at Broken Hill. You have given proper credit to Elmore, but what has become of poor old Potter? "Oh, he is dead," I hear somebody say. Yes, and he died poor and disappointed, and by that recompense qualified for the ranks of the immortal inventors of past ages. Some 11 or 12 years ago, visitors to Broken Hill were freely shown the Potter and Delprat processes in full work on a large scale. It was obvious that both processes were essentially the same, and it required an expert to detect differences in detail. At that time the Central mine was said to be experimenting with the granulation process, and visitors were refused admittance. What has happened since? The process has not altered in principle, or in appearance; to the non-expert eye the working and the results are the same. To the unbiased expert, as you and others have so often pointed out, the alterations, making for better work, were bound to be found out sooner or later by ordinary engineers accustomed to adapting new processes to varying conditions. That is all.

The clever men who have experimented and found out so many things, making the process cheaper and easier and of wider application, are entitled to honor. But that an obscure later explorer gave his name to the New World does not alter the fact that Columbus really discovered America or diminish his fame. You referred to the "flotation vendetta" in London. That is bad enough, but what is worse, and what began it, is the "patent grab" in Victoria. It is ancient gossip that the richest of the Broken Hill companies determined long ago to pay no royalties to anybody for treatment processes, and the company was so powerful and its officers so clever that it was left alone. Other smart* mining firms in Melbourne (than whom, an old Comstock miner told

*'Smart' is modern slang for 'legal but dishonorable.' See any dictionary.—AUTHOR.

me years ago, none are superior), as soon as it was seen that flotation, by the principle (not then understood) underlying the Elmore and Potter processes was going to solve the mixed sulphide problem of Broken Hill, set a host of clever chemists and metallurgists to work to find flaws in the patents, or modifications that could be patented and made bases for royalty claims and legal threats to enforce them. With a principle, which is so subversive of all our previous ideas of concentration, to be tried, it is no wonder they succeeded. The opportunities presented by the modern world to anybody who can obtain the legal monopoly of the right to utilize a hitherto unrecognized natural force, capable of world-wide profitable application, are such that everything which has followed since was a matter of course.

It is a sordid story, and adds force to those who believe the world would be morally better were there no patent laws.

AUSTRALIAN MINER.

Sydney, N. S. W., January 6.

Uneasy Miners at Adelaide

The Editor:

Sir—This place, Adelaide, an old mining district, is 12 miles south of Golconda, Nevada. At times during the past four or five years we have frequently noticed noises that sounded like the rumbling of a subterranean river. In 1912 I was doing assessment work on some claims in the Jungo desert, a mile and a half west of the Western Pacific railroad, and seven miles south of Jungo station. At that time I heard a noise that at first I thought to be an approaching automobile or a train. From that time on, and up to the present, these strange rumbling noises have continued, and have deceived many people as they did me.

In February 1915, while my partner and I were placer-mining a mile and a half from here, ashes from Mount Lassen, in California, fell all over this part of Nevada. At that particular time this curious buzzing noise was more noticeable than before. At one time we had an uneasy 'hunch' that something was going to happen and in the afternoon of that day, about 3 o'clock, we heard the noise I have referred to, and others heard it as well. Mrs. Playter, two miles from here, heard it and went to her front door to see who was coming in an 'auto.' The sound always seems to come from the west. At 3.30 p.m. that day we felt a distinct earth-shock, and another at 6 o'clock, while at supper. I then remarked to my partner that I would not be surprised if we got a good shaking before midnight, and we did. I shall never forget it! It was intensely cold that night, though the weather had been particularly fine for several days just before that. I stayed up from midnight until 5 a.m. and during that time I counted 350 shocks, then gave it up. Many people about here slept in their clothes for a week after that, and I was one of them. I believe these earthquakes had some connection with the eruptions of Mount Lassen.

We felt two earth-shocks on January 16, and additional shocks on January 17, 18, and 22. This afternoon, January 24, we felt a shock at 1 p.m. and another at 8:30. It is nothing new for this district. Ranchers say they felt shocks 30 years ago at Grass Valley, 25 miles south of here. Winter's ranch, 7 miles south of Adelaide, would be a good place for a seismograph. The family that used to live there abandoned the place because of the almost constant shaking of their house. The blasting in the old Adelaide mine, a quarter of a mile from here, shakes our house like an earthquake. This is a mining region but repeated earth-shocks do nothing toward insuring the safety of men working underground.

LORING HANSON.

Adelaide, Nevada, January 24.

[Earth-tremors are surficial. Men working in mines are safer than those on the surface. The earthquake of 1906 did no damage underground in mines.—EDITOR.]

Misfires

The Editor:

Sir—In your issue of February 3, Mr. E. F. Brooks, in replying to my discussion of his article on misfires, sets forth some ideas regarding the making of primers that I feel are open to question. Before discussing this particular point, I might call attention to the fact that the opinions held by men experienced in the loading and shooting of holes in various parts of the country are quite variable. It is not surprising, in view of the many grades and qualities of caps and fuse on the market, that this difference of opinion should exist. I believe that much good could be accomplished were it necessary for manufacturers of caps and fuse to submit their material to the Bureau of Mines for examination. The Bureau could establish a permissible list, the same as it does in the case of powder used in coal mines, thus guaranteeing to the public that the product offered for sale will come up to certain set requirements.

Mr. Brooks states that the method of making primers preferred by him is "to punch a diagonal hole in the powder near the end of the cartridge, insert the cap, and bend the fuse across the end of the powder, and insert in the hole, cap end first." This method doubtless is all right, provided the fuse is of a good grade and provided it is not cold. With poor fuse or with cold fuse I believe that this method will cause misfires. Obviously, it would not do to have rules to fit the different grades of fuse.

The methods of making primers submitted in my letter in your issue of January 6 were approved by the Bureau of Mines after an exhaustive series of tests, many of which were made at mines under conditions as encountered. Furthermore, these methods are approved by the leading powder manufacturers. Certainly such approval should be convincing. While in the employ of the Bureau of Mines, during a period of more than four years, I had occasion to investigate closely this subject in the most important metal-mining districts of the United States and thus became somewhat familiar with

the subject of misfires and their causes. In many mines, especially in the Lake Superior region, I found the use of the wooden punch for making a hole in the cartridge to be common. Also, I found that in many mines all primers were being made properly, the penalty for making them in any way except the one approved by the management being dismissal on the second offense.

Investigation in California discloses the fact that primers are commonly made by means of punching a hole in the end of the cartridge, inserting the capped fuse and bending the fuse back through 180°—and 25% of the miners killed in California during 1916 met their death as a result of misfires. Of course, this cannot all be blamed on the method of making primers, but with a percentage of fatalities from misfires that so far passes the record of other States, it appears that there is a mighty weak spot somewhere.

It is only fair to add that the bend occasioned by placing the capped fuse in the bottom of the cartridge is slightly greater than the bend necessary when a diagonal hole is punched "in the powder near the end of the cartridge." Thus, the method suggested by Mr. Brooks is somewhat of an improvement on the method referred to in the foregoing paragraphs. However, I would not recommend either of these methods for general use.

EDWIN HIGGINS.

San Francisco, February 5.

Sampling Small Lots

The Editor:

Sir—I have known for a long time that among shippers, and particularly small shippers, there is a very hazy idea of the methods of sampling ores used at the custom smelters, and in connection with the recent article, January 27, under 'Discussion,' by Mr. Lovejoys, I would like to make a few remarks that I believe would be a direct benefit to small shippers in general, who are unfamiliar with these methods.

In the case of the first lot mentioned, the fact that Mr. Lovejoys valued the lot at $1100 for 380 lb. whereas an independent assayer gave $10 per pound as his valuation shows something radically wrong. Surely no amount of 'perfumes' would account for such a difference. The Editor remarked in a recent interview that to find the number of raisins in a cake, you must eat the cake. This certainly applies to an ore containing coarse gold, and may account for the wide variation in assays between Mr. Lovejoys, the independent assayer, and the smelters. Since the smelters are aware of this fact, the invariable practice in handling small lots of such ores is to crush the entire lot so that it will pass a 30-mesh screen, weigh the metallic residue, if any, and assay it separately from the pulp. But Mr. Lovejoys says that no mention was made of 'metallics' in his settlement. Now, it does not necessarily follow that there will be metallic residues after grinding, even though the ore may contain coarse gold, as a very small amount of arsenic in the gold will render the metal so brittle that it will be ground up with the ore and pass through the screen. Mr. Lovejoys states that the smelters gave the moisture content as 6.4%, and the ore was "dry and dusty." Now, there is a possibility of a mistake being made at the smelter, in view of which the shipper has the privilege of seeing the entire operation, or he may appoint a representative for that purpose. It is also a fact that ores, dusty and apparently dry, often do contain more than 6.4% moisture. The ore in question was hematite, and undoubtedly contained some limonite—the brown hematite that even in a perfectly dry state carries 14.4% moisture in the form of water of composition, a part of which will be driven off in the process of drying a sample. I might liken it to bluestone, which, though perfectly dry, will give water at ordinary room-temperature. I would advise anyone doubting this to weigh about two pounds of ore that he thinks is dry, leave it in the oven for 10 or 12 hours, and weigh it again, noting any difference in weight.

In regard to concentrate, a copper sulphide containing 8% moisture would be very damp on account of the fact that the moisture is practically all on the surface of the mineral particles, whereas an ore containing a like amount of moisture may barely show it on the surface—in fact, copper ores are notoriously deceptive as to moisture. I have seen many copper ores so dry that it was necessary to moisten before sampling, and these ores would show 10% moisture in their dry state.

I cannot believe that Mr. Lovejoys is in earnest about the suggestion of the "gentlemanly agreement"* between the smelters and the railroads. In conclusion, I wish to say that I am not connected in any way with the smelters, but, on the contrary, am engaged in representing the shippers at the smelters, so that I am perfectly familiar with the methods followed in sampling.

FRED. G. TYRREL.

San Francisco, January 29.

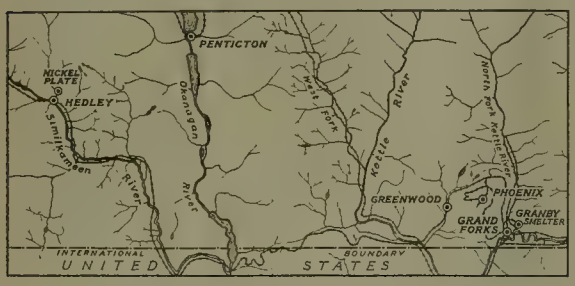
MEXICO is now once more practically on a hard-cash basis, but facing difficulties inasmuch as the hard cash necessary does not exist in the country. In 1912 silver was only used for payments under five pesos, larger amounts being paid in bank-bills. Since 1912 much silver has been exported by the Government for purchase of their requisites, and a good deal has been melted and exported by individuals. Furthermore, bank-bills no longer circulate, hence the scarcity of hard cash. It will be necessary either to bring in and use American money (which, of course, is not strictly legal tender, although it is extensively used along the border and coast districts), or for the Government to get out some new guaranteed bills, or make arrangements for the use of the old bank-bills. Thus all paper issues for the last two or three years have successively gone to the wall, none of them having been redeemed and with little probability of their redemption. This may be the best way to get rid of this obligation.

*The statement made was that "shipments made through the express company invariably realized nearer our assay than did shipments made by freight."

Grand Forks and Phoenix, British Columbia

By T. A. Rickard

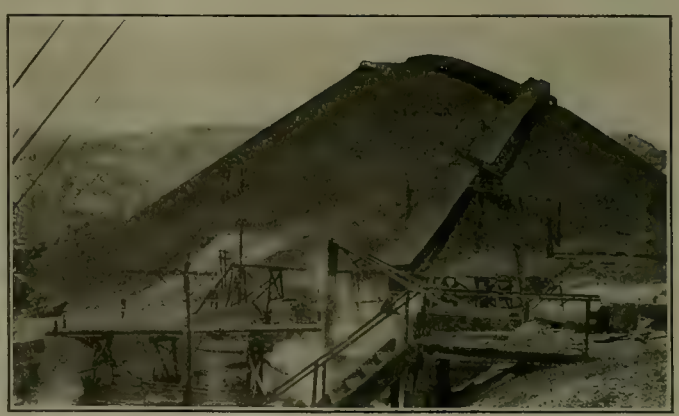
Among the important American enterprises established in British Columbia is the Granby Consolidated Smelting, Mining & Power Co., which owes its name to the town of Granby, in Quebec, that having been the home of S. H. C. Miner, who organized the company, in conjunction with J. P. Graves, of Spokane, in March 1901. Subsequently the American Metal Co. became a prominent factor in the business and for several years the president of the metal company, the late Jacob Langeloth, was president of the Granby Consolidated. This company was formed to exploit the Knob Hill and Old Ironsides mines at Phoenix, in the Osoyoos district, and to operate the smelter that was built at Grand Forks. A. B. W. Hodges was local manager and W. Yolen Williams was consulting engineer for many years. To them may be credited the successful development of the undertaking. Both have now retired, F. M. Sylvester being managing director and vice-president. To Mr. Hodges is due special recognition for the design and equipment of the smelter at Grand Forks.



MAP OF PART OF BRITISH COLUMBIA.

I went there on a broiling day when the conical slag-heaps and the cloud of smelter-smoke amid the sunburnt hills composed a scene suggesting volcanic activity. The two black cones of slag constitute the characteristic feature of the picture. They represent the refuse from the smelting of 12,000,000 tons of ore. The bigger one contains 2,000,000 tons. As the slag flows from the blast-furnaces it is granulated at four places by impact with a jet of water, which washes it into a bin outside. Here it is de-watered and then conveyed on six belts working in tandem, the total length being 1600 ft. The foremost belt is telescopic, so that it can be pushed forward as desired. This equipment has a capacity of 9000 tons per day. The other dump and its belt-conveyor serve as an auxiliary discharge.

Two railway lines, those of the Canadian Pacific and the Great Northern, enter the smelter-yard. The cars, as they arrive loaded with ore from Phoenix, or from elsewhere, are emptied into bins arranged in series along five tracks. The first of these serves the sampler and the other four supply the furnaces, two tracks for coke alternating with two for ore. Both railways go to the copper mines at Phoenix and both touch Crow's Nest Pass, from which comes the coke. About 1000 tons of custom ore is received monthly, chiefly from Republic, in the adjoining State of Washington, but some ore comes also from mines in Idaho and Montana, besides occasional shipments from British Columbian districts. Eight blast-furnaces and three converters are in use, smelting 3500 tons of ore daily and employing 195 men altogether. A train of three charge-cars feeds each pair of furnaces alternately. The coke is charged separately, at the rate of 400 to 450 tons daily. As much as 550 tons of ore has been put through a single furnace in one day. The small number of men employed is noticeable. The wage-scale is based on a $3 rate for common labor, but the men now receive $1.25 per day more on account of the higher price of copper. The employees are a good class of men, many of them owning farms in the adjacent Kettle valley. When the European war began, the plant was shut-down for five months, owing to the collapse of the metal market. The men accepted a 25% reduction in their wages, so that the minimum pay for awhile was $2.25. Now they are recompensed. The labor employed is mixed: Canadian, British, and American. Real foreigners are rare on the pay-roll.



ONE OF THE SLAG-HEAPS, SHOWING CONVEYOR SYSTEM.

The three charge-cars enter the blast-furnace, a rail three feet above the track receiving the small subsidiary wheels placed along the top length of the cars so as to empty them. This self-dumping charge-car was de-

signed and patented by Mr. Hodges, when manager, in 1905. The system of charging was worked out by Messrs. Hodges and Williams. The furnace is set at right angles to the line of front. At Anyox the furnaces are lengthwise of each other. The water-jackets as already described. The lining of the conduit that carries the granulated slag is made of slabs of slag, 18 by 24 inches, and 3 inches thick, reinforced by a sheet of 'trussit metal,' a herring-bone metal lath, the idea for which came from Anaconda. This lining lasts for two

THE GRANBY SMELTER, AT GRAND FORKS, B. C.

THE CONVERTERS, SLAG-POTS, AND COPPER-MOULDS.

are in two tiers, so that they extend to 12 ft. above the base-plate. Each furnace has not less than three settlers; and as a pair of furnaces may have two settlers in common, the slag passes through five settlers. The settlers are made in the shape of the frustum of a cone so as to render the 'sow,' or mass of low-grade matte, easily detachable when it has chilled. The slag is granulated, years, as against the four months' life of the various steel linings that have been tried. The side and bottom 'slabs' (or bricks of slag) are interchangeable and are easily replaced when worn out. When running at full blast, the consumption of water is 4500 gal. per minute, all of it being discharged at the boiling-point.

On the charge-floor 12 men are employed when smelt-

ing at full capacity; on the furnace-floor 10 are required, including two helpers. The electric crane saves a lot of manual labor. This equipment consists of two 10-ton cranes in the furnace-room, connecting with a 40-ton crane in the converter department. Electric power comes at 60,000 volts and is transformed to 440 volts.

The converter department contains 3 stands and 10 shells. Five men are employed. At the time of my visit I saw three converters in different stages of activity; one converter was in blast, shooting its gases up the hood noisily; another was in the act of pouring slag, being tilted so as to discharge into a 5-ton pot; the third converter was pouring blister copper into moulds, each holding 200 lb. of 98½% metal. After the slag had drained out of the second converter, a scoop or 'boat' was lowered and tilted from the crane, so as to feed the quartz ore needed to supply the requisite silica. The slag-pot was lifted by the crane and taken to the tilting-cradle in front of a pan-conveyor. Then the pot, now lined with slag, was used to convey matte, the crane taking the pot to the blast-furnace, where it was filled with material to be 'converted.' When the shell of slag lining the pot becomes too thick, it is discharged on the ground and broken into small fragments by dropping a big steel ball upon it. Then the pot is given a clay wash and resumes its round of duty.

While standing observant I saw a surgical operation performed on the throat of the first converter. This had become clogged with an accretion of matte and slag, which had to be removed, otherwise the outlet for the gases of combustion would be insufficient and the metallurgical process would stop. Therefore this accretion was removed by aid of a large forged-steel hook, the point of which is capable of being detached and sharpened by the blacksmith. This hook is operated by the 40-ton crane, being lowered into the mouth of the converter so as to pull out the accretion, like a dentist's forceps, and drop the clotted mass into the converter for re-fusion. Greek and Austrian magnesite is used to line the converters.

The slag from the converters is removed on a pan-conveyor discharging into a bin from which railroad-cars are loaded, to discharge their load in turn into the bins at the back of the smelter. In falling from the conveyor, the slag shatters itself sufficiently to render any crusher unnecessary. Each pan holds 100 lb., the capacity of the conveyor being 250 tons per 24 hours, or more than is required. The blast-furnace slag is maintained at about 46% silica, the iron and lime adjusting themselves automatically at 15% iron and 21% lime. Ten tons of ore is charged at a time, from the three cars, together with 13.17% coke—that was the average in 1915. Each furnace smelts 400 to 500 tons per day, so that theoretically a ton takes 1/45th of 24 hours or about half an hour, but the metallurgist does not look at it that way because he knows that the ore remains in the furnace until it is smelted. Chunks of refractory ore may linger in the cooler part of the furnace for a whole week.

The ore from Phoenix is practically self-fluxing. No roasting is done. The slag that goes to the dump contains 0.21% copper. The cost of smelting and converting at Grand Forks was $1.23 per ton of ore in the year ended June 30, 1916.

One smoke-stack bears the date 1900; the other, 1905. These were the years in which the plant was built and then enlarged. The original plant, built in 1899 and blown-in during August 1900, was intended to treat the ore from the company's mines at Phoenix; it consisted of two small (44 by 160 in.) blast-furnaces, and, as the ore was both low-grade and self-fluxing, the plant could be made simple in design with due regard for the economical handling of ore, coke, flue-dust, matte, slag, and metal. After a few months of operation had shown that a small profit could be made on each ton of ore it became only a question of large tonnage to make the business profitable on a much larger scale. In the following two years two furnaces and three converter-stands were added; in 1904, two more furnaces; in 1905 two more, 48 by 213 inches. In this year the length of the smaller furnaces was increased to 266½ inches and the old converters were replaced by three new ones, 84 by 126 inches.

During 1916 the coal strike in District No. 18, which includes the coal-fields of eastern British Columbia and the whole of Alberta, interfered with the supply of coke. Between August 2 and August 10 five thousand men were idle. Then an accident in the No. 3 mine at Michel caused the death of 12 men. The accident is supposed to have been due to lightning entering the mine and exploding the gas. The interruption to the supply of fuel compelled the management to reduce the work of the furnaces to one-half, but the shipment of matte from Anyox kept the converters busy and enabled the production of copper to be maintained at normal, as explained to me by W. B. Bishop, the smelter superintendent, to whom I am indebted for many courtesies. His chief, W. A. Williams, who is superintendent of smelters, was at Anyox at the time of my visit. Under the direction of Mr. Sylvester, the Granby Consolidated has expanded its activities and increased its profit by the acquisition of the Hidden Creek mine, on Observatory inlet, on the coast and about 600 miles north of Vancouver. This big copper deposit was acquired from M. K. Rodgers and associates in 1912, and in 1914 the first unit of the new smelter at Anyox, two miles from the Hidden Creek mine, went into operation. The mine has been developed to the point where 18,000,000 tons of 2½% copper ore is assured and the capacity of the smelter is now such as to treat 3000 tons daily. During 1916 the converters were unable to cope with the increased output of matte, so that a considerable tonnage of it went to Grand Forks. The blister copper, both from Anyox and Grand Forks, is shipped for refining to the Nichols Copper Co. in the State of New York.*

To Mr. Hodges I am indebted for the following notes:

*A description of the metallurgical operations at Anyox, taken from the company's annual report, appeared in our issue of November 25, 1916.

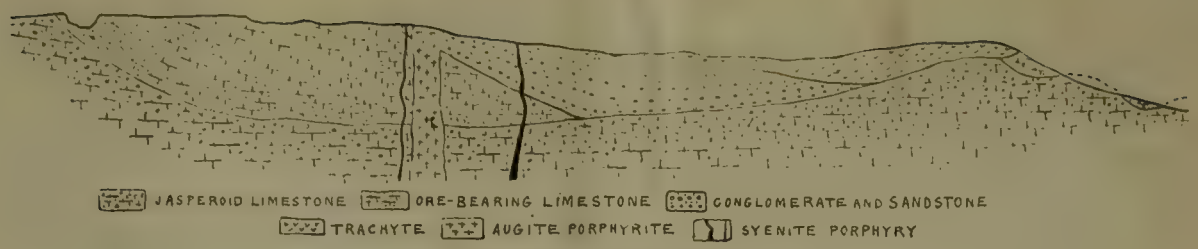


FIG. 1. CROSS-SECTION OF THE PHOENIX DISTRICT.

"An article published in your issue of February 13, 1909, gives a good idea as to the smelting-plant in December 1908. I might, however, bring out certain points wherein the Granby smelter is different from other plants; these are as follows: position of blast-furnaces, charging-system, settling blast-furnace slag, handling of the slag.

"Of course, you noticed that the eight furnaces were all set parallel to one another and not end to end as is now the practice in all new plants; this I decided to do at the start in order to be better adapted to a certain mechanical furnace-charging device that I had invented and wanted to install at the beginning. At this time you must remember that in almost all of the copper-smelting plants the furnaces were fed by hand.

"The method of charging is peculiar to the Granby plant; it is adapted to furnaces set parallel to one another and is only used at one other smelter, namely, at Trail, B. C. The particular advantage of this system is that the charge-cars run right in the end of the furnaces and the charge is dropped, without altering, but to a very small extent, its previous arrangement, thus enabling one to place the coke and fine ore along the jackets, and the coarse ore in the centre of the furnace, or leave out charging certain parts, or put a special charge in a certain spot, and at the same time put the regular charge in the rest of the furnace.

"The only other mechanical feed that is better than this was invented some years ago by W. H. Freeland, but his is only adapted to furnaces that have an unobstructed charging-floor, such as are not built nowadays. A good description of Mr. Freeland's system is found in an article by David H. Browne, published in the Canadian Mining Institute bulletin for November 1916. As a rule, in copper plants the furnaces are placed end to end and fed from the side by cars that roll or dump or slide the charge in, thus upsetting any pre-arrangement.

"The blast-furnace slag, after being granulated by water is run on a belt and elevated to a great height, and I think that this is the only copper smelter where this method is used. This scheme was adopted after I left the plant for South America in 1910; before that we used to handle the slag hot in large slag-pots, which were hauled to the dump by small steam-locomotives, but as about all the available space became filled up and the haul became too long, the belt-elevator was put in.

"You probably noticed that there were three small settlers before the furnaces instead of one large 18-ft. settler. The reason that I adopted the smaller size was on account of the very high silica in the charge; a high percentage of coke was necessary, and this condition formed a comparatively large amount of what the foreman called 'metallics,' which built up the bottom of the settlers rapidly; therefore

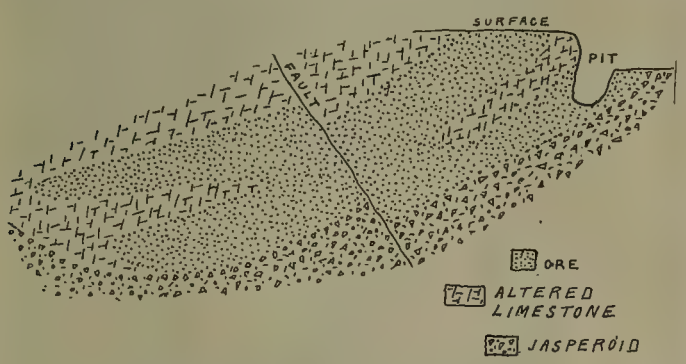


FIG. 2. A FAULT.

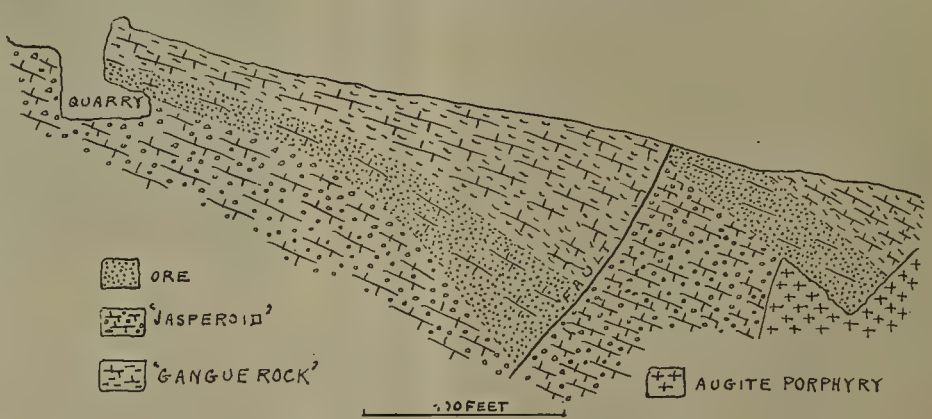


FIG. 3. FAULTING OF AN OREBODY.

when a small settler became filled up to such an extent that it was not efficient, an electric crane picked up the whole thing and put a new one in its place in a few minutes, whereas if a large one had been used the furnace would have to be shut-down while repairs were being made. On account of the little settler being too small to properly settle the matte out of the slag a second settler was added and afterward a third, which I really think is more efficient than one big one.

"Another thing you probably noticed was that the air for the blast-furnaces came from blowers situated at each end of the plant, and also that the flue-chamber was divided in the middle, the gases and flue-dust from four furnaces going to a separate chamber and stack. This is not modern practice, but was brought about by increasing the capacity of the plant from two furnaces of 800 tons per day to eight furnaces of 3500 daily capacity without building an entirely new plant and without losing a furnace-day, and at the same time keeping the smelting-cost down to the lowest figure."

Phoenix is 9 miles, as the crow flies, from Grand Forks, but the wagon-road is 15 miles long and the railroad 26 miles, the difference of altitude being 2500 feet. The Granby Consolidated controls nearly all of the productive ground remaining at Phoenix, most of the outside properties having been worked to a finish.

The journey in an automobile along an excellent road is most pleasant, giving a view first of the smiling valley and then of the forested hills. On arrival we went to the Gold Drop mine, and from the dump viewed the panorama of mountains. Due east is the peak called Old Glory, near Rossland, and north the range overlooking lake Christina and the Arrow waterway. The International boundary—which I do not claim to have seen—is only 6½ miles away. At the foot of the dump were signs of the Snowshoe workings, owned formerly by the Snowshoe Gold & Copper Mining Co., of London, and leased for several years to the Consolidated Mining & Smelting Co. of Canada before being purchased by the Granby company three years ago. The ore was low-grade and the tonnage insufficient to warrant the erection of a smelter by the English company.

The main orebodies of the Granby properties, notably the Knob Hill and Ironsides mines, have been found along the western foot-wall of the 'jasperoid' while the Gold Drop workings are on the eastern side of the hill, also on the foot-wall. The geology of the ore deposits has been described and explained by O. E. LeRoy in Memoir No. 21 of the Canadian Geological Survey. The accompanying cross-sections are taken from that memoir.

The accompanying section (Fig. 1) of the Phoenix district is taken from Mr. Le Roy's report, but a slight alteration has been made at the east end of the section in accordance with the evidence obtained in later exploration underground.

The Phoenix orebodies are typical replacements of limestone at or near the contact with an igneous rock. In this locality the limestone is the Brooklyn formation, probably of Carboniferous age. The igneous rock that produced the contact metamorphism has been eroded, but there is reason to infer that it was some off-shoot from the batholith of grano-diorite, such as the syenite-porphyry, dikes of which cut the mineralized zone.

The orebodies in the limestone have a flatly lenticular shape occupying depressions having usually a floor of 'jasperoid,' although unaltered limestone or tuff may also form the base. The jasperoid, which overlies the tuff, is a chalcedonic agglomerate marking lines of brecciation in the limestone or in calcareous tuff. It forms the so-called foot-wall of the principal orebodies and passes upward into a metamorphosed limestone, called 'gangue,' composed of epidote, garnet, quartz, calcite, and chlorite. Magnetite is found both within the ore and bordering it. Waldemar Lindgren, who examined thin sections of the ore for S. F. Emmons several years ago, stated then† that the specimens "showed pretty clearly that a metasomatic replacement has occurred, during which a granular limestone has been converted into amphibolitic rock, and that simultaneously, or almost simultaneously, magnetite and sulphides have been developed." Emmons himself had visited Phoenix and remarked upon the curious association of magnetite with the sulphides of iron and copper. He noted the lack of fracture-planes or walls enclosing the orebodies, or even defining their direction, emphasizing the fact that the ore grades off insensibly into rock that is not 'ore,' owing to its poverty in copper. The valuable mineral is chalcopyrite in a rock that carries 1.25% of copper and about $1 per ton in the two precious metals.

The orebodies range in size from lenses 5 ft. thick and 50 ft. long to masses like that of the Knob Hill and Ironsides mines, 125 ft. thick, 900 ft. wide, and 2500 ft. long. The first ore was traced underground from outcrops, but the larger exploration of the district was done by aid of diamond-drilling, which furnished the information on which the broad outlines of the ore-bearing limestone could be ascertained with an accuracy sufficient to guide systematic development. By such methods the mineralized zone has been so thoroughly prospected that the probabilities of finding more ore have been exhausted and it has become recognized that the life of the mines remaining active is limited to about three years more on the present shipping basis. It will, however, be impossible to work at all points simultaneously and the life of the district therefore is likely to be prolonged.

In March 1910 the shareholders of the Granby Consolidated were shocked by the publication of a report made by Otto Sussmann. He stated that the reserve of ore amounted to 6,826,920 tons averaging 1.25% copper. A great deal of unnecessary fuss was made over this report, for Dr. Sussmann had merely emphasized facts that should have been made clear previously in the company's annual reports. The definite limits of the ore-bearing ground had been ascertained by the Geological Survey, the members of which had been quite frank with the company's engineers. Mr. LeRoy had

†'Genesis of Ore Deposits.' Trans. A. I. M. E., page 761.

examined the district in 1908 and re-visited it during 1909, so that the main outlines of the local geology were well known early in 1910. In the six years since, that

1. FRONT VIEW.

2. BACK VIEW.

3. SIDE VIEW.

is, from July 1, 1910, to July 1, 1916, the output of ore from the Granby Consolidated mines at Phoenix has been 5,853,164 tons averaging 1.1% copper and there remains still 3,610,000 tons estimated to contain 1% copper, with 75 cents per ton in gold and silver. C. M. Campbell and the other engineers on the staff acknowledge gratefully the friendly aid of Mr. LeRoy and his fellow-geologists, who before they left the district, in 1910, gave the management the use of the preliminary maps. The geologic data thus obtained have proved of great assistance in prospecting the ground.

The connection between orebodies and fissures is not often obvious and the suggestion has been made that the limestone was impregnated by solutions that found their way through joints and minor fractures. On the other hand, the foot-wall, which is so well defined in the Electric Shovel pit, looks as if it might have served as a channel of circulation. This seems to be Mr. LeRoy's opinion for he states that "the fissures have undoubtedly been the important factor in the deposition of the ore."

At present 18% of the output comes from surficial mining. The largest open-cut is over 2000 ft. long and has a maximum width of 400 ft. Excavation is done by use of a Bucyrus No. 40R electric shovel, provided with a 1½-cu. yd. dipper, and a 'jack' on each side to brace the machine when lifting on the opposite side. The cars contain 10 tons each when heaped, the nominal capacity being 7 tons. They are equipped with the automatic side-dumping subsidiary wheels, as shown in the accompanying photographs. This car is known as the Granby, having been designed by the engineers of this company. It is used in many of the British Columbian mines, notably at Anyox and in the Britannia mine.

These ore deposits have been a great source of wealth, despite their low tenor, because they have been self-fluxing. My friend Ralph Stokes, now "doing his bit" with notable success "somewhere in France" visited Phoenix in 1907 and in his book he gave the typical analysis:

	%		%
Lime	18—22	Alumina	6—7
Silica	38—40	Magnesia	6—7
Iron	10—14	Sulphur	2—4.5

He also remarked‡ on the tendency to an increase of silica in depth, but Mr. Campbell is of a different opinion. In the light of the later evidence of deeper workings he is able to state that the silica seems to be "pretty uniformly distributed." With the exception of the garnet, the concentration of any one mineral is not characteristic of any particular part of the orebody.

NICKEL mining is of first importance in Ontario. In 1915 the nickel contained in Sudbury matte amounted to 34,039 tons, valued at $17,019,500. In 1915 the output was 42,000 tons, worth $21,000,000. During 1916 both of the operating companies, the Canadian Copper Co. and the Mond Nickel Co., worked to their fullest capacity their mines and smelters in Ontario, as well as their refineries, one of which is in New Jersey, the other in Wales. Another source of nickel in Canada is the nickel oxide obtained by the refineries from the ore of the Cobalt district. A little metallic nickel was obtained elsewhere during the year, but production was relatively unimportant.

‡'Mines and Minerals of the British Empire,' page 347.

The Emerald Mines of Colombia

The emerald is a gem that rivals the diamond in beauty and in value. It is not nearly as hard as the diamond, in this respect ranking with topaz, but flawless stones of good color are highly esteemed. The principal emerald mines of the world are in Colombia about 80 miles north-west of the city of Bogota, in an almost inaccessible part of the Andes, at the head of the Orinoco river. These mines were worked centuries ago—long before the conquest. The Spaniards operated the mines with vigor, impressing the Chibcha Indians into their service. At that time the natives placed their treasures beyond the reach of the *conquistadores,* so says the story, by throwing both gold and gems into the lakes. One of these bodies of water was Lake Gutavita, which is said to be the place of the fabled El Dorado—the gilded man—and from which came the many traditions of the 'Land of El Dorado,' so eagerly sought, though vainly, in the 16th century.

The story of El Dorado can be told briefly: The Indians were accustomed to celebrate the accession of a tribal chieftain with elaborate ceremonies, during the course of which the young chief, smeared with a thin layer of clay and then covered with a film of beaten or dust-like gold, proceeded on a raft to the centre of the lake, and there, as a sacrifice to the gods, threw overboard a great quantity of gold and emeralds.

The emerald deposits, after a long search, were discovered by the Spaniards, near the crest of the Andes. The Indians had worked them during each rainy season, breaking down the gem-bearing ground with wooden bars, assisted in the operation by small streams of water delivered from ditches. The Spaniards found open pits and dumps of waste-rock so large as to make it evident that work had been in progress for a long time, probably for centuries. At first they adopted no systematic method, although they obtained a rich reward from such careless work as they did. Later, however, realizing the great value of the mines, the Spaniards took complete possession, and it is said that 1200 Indians were employed there in 1565. Four times a year shipments of the precious stones were made to Spain and for 150 years mining continued under Spanish ownership, but toward the last the expense became greater than the value of the product and the mines were closed down by order of Charles II.

Soon thereafter the luxuriant tropical vegetation covered the pits and the mines were lost to all but tradition. It remained for an enterprising Colombian, Francisco Restrepo, to re-discover one of the ancient workings, guided by a description in an old Spanish tome and a parchment map. But these deposits appear to have been exhausted and proved unprofitable. Exploration by the early Spaniards, however, had resulted in the finding of other emerald mines that were being secretly worked by the natives. Among these the deposits at Muzo were the most important, but still other deposits were discovered, notably those at Coscuez, north-west of Muzo. At the Coscuez mines some of the operations were underground, and it is stated that at one time 300 Indians were killed by the caving of the workings, this accident causing work to be suspended for a long time. Work was resumed early in the 19th century, but these mines, too, were abandoned and soon were overgrown by a dense growth of jungle. They were re-discovered a few years ago, and when work is resumed there it will be under the auspices of the Colombian government, which controls the emerald mines of the republic.

The emerald mines of Muzo are thus described by Joseph E. Pogue, of the Northwestern University.* "The mines consist of a series of some eight large open-cuts, which lie closely grouped on the steep slopes of a densely-wooded mountain. From a little distance the main workings seem to form a huge funnel-shaped depression, which appears in striking contrast to the long velvety slopes of green. Entering this crater-like opening through a narrow canyon below, or looking down upon it from its rim above, one sees in detail, the individual cuts as sloping banks of terraces resembling giant stairways. Across these working-faces, which consist of folded and contorted beds of coal-black limestone and shale, stretches an irregular network of white threads, gleaming in the tropical sun like zigzag lightning flashes in a field of black. These are the calcite veins which carry here and there, but none too abundantly, small cavities or nests lined with tiny crystals of emerald and associated minerals.

"The emeralds, when freed from their matrix are seen to be small six-sided prisms of rich green color, ranging from the size of a man's thumb to microscopic dimensions. The flaws, or internal cracks, characteristic of these as of all other emeralds, are not always present in the freshly mined stones, but if not they almost invariably develop soon after the specimen is removed from the inclosing rock, a result presumably caused by a strained condition of crystallization. Recently a few remarkable crystals have been found showing a tapering hexagonal core and six-rayed star of carbon dust.

"The mines up to 1913, when operations ceased, have been worked in a rather simple manner by Indian laborers or peons, breaking down the friable emerald-bearing rock with long iron crow-bars and picking out the emerald veins by hand. A regular attack in this manner along definite lines gives rise to the horizontal sets of benches or terraces so characteristic of recent workings. It would seem that modern types of mining machinery, such as the steam-shovel, might be profitably introduced; yet, so fragile are the emerald crystals that the operations may have to continue to rely largely on individual effort.

"From the end of the 16th century to 1830 practically all the emeralds that came upon the European market were obtained from Colombia; and such is the source of probably the majority of emeralds in circulation today, outside of the Orient."

*Trans. A. I. M. E., May 1916.

FIG. 1 AND 2. LOADING AND DISCHARGE STATIONS.

The Spanish Peak Aerial Tramway

By J. A. Kitts

Aerial tramways, as designed and built today, represent the application of sound engineering principles, based on experience derived from the design, construction, and operation of several thousand lines, having a total length of many thousand miles. They have become recognized as an economical and practicable means of transportation. They are especially adapted to mountainous country, and solve the problem of transportation to and from territory that is economically inaccessible by surface lines.

Aerial tramways have been built for many purposes, as indicated in the following list of notable lines:

Company and locality	Length, ft.	Capacity per hour	Material
Bethlehem Steel, Bethlehem, Pa	1,900	200 tons	limestone
O'Brien Munitions, Renfrew, Ont	900	2½ "	cotton in cans
Carnegie Steel, New Castle, Pa	3,700	150 "	flue dust
Tacoma Smelting, Tacoma, Wash	2,850	100 "	ore
Spanish Peak Lumber, Quincy, Cal	27,200	15 "	lumber
Am. Smelting & Refining, Christmas, Ariz	7,350	40 "	ore
Con. Interstate-Callahan, Wallace, Idaho	10,475	25 "	zinc concentrate
Butters-Divisadero, San Salvador, C. A	11,750	20 "	ore
Baker Mines, Cornucopia, Ore	5,500	15 "	"
American Zinc, Mascot, Tenn	1,900	60 "	"
Kennecott Mines, Kennecott, Alaska	15,150	25 "	"
Cassidy Coal, Curwensville, Pa	4,635	20 "	coal
Spring Canyon Coal, Provo, Utah	2,900	250 "	"
McKinley-Darragh, Cobalt, Ont	4,800	5 "	ore
Tomboy Gold Mines, Telluride, Colo	6,800	15 "	concentrate
Saline Valley Salt, Bishop, Cal	69,925	20 "	salt

The Spanish Peak aerial tramway is unique in that it was designed and built for the purpose of carrying sawed lumber for commercial purposes direct from the saw-mill and yard over a mountain range to a connecting railroad. This development is of particular interest since our forests are largely confined to rugged and mountainous country. The lumber company's property is at Spanish Ranch, seven miles west of Quincy, Plumas county, California, and about five miles by air-line from the Western Pacific railway. The easiest surface-line route from Spanish Ranch would be by way of Spanish creek, connecting with the Quincy Western railroad at Quincy. Spanish creek, however, is so tortuous and the general topography is so precipitous as to make it impossible to construct any type of surface-line for a reasonable amount of money.

The aerial tramway was selected as the only feasible means of carrying lumber from this territory, on a commercial basis.

The saw-mill and drying-yard of the company are at Spanish Ranch, and the manufacturing plant and storage-yard are at Grays Flat, on the Western Pacific railway. The tramway connects these two points, and is a little over five miles long. It has a normal capacity of 15 tons or 10,000 ft. B.M. per hour, when running at the rate of 414 ft. per minute. This capacity may be increased somewhat by increasing the speed of the hauling-rope. The discharge-terminal is 890 ft. lower than the loading-terminal, and the tramway, when running under normal load, develops 10 hp. To utilize this power, a 15-kw. generator has been connected to the control-unit, the power generated being used for lighting and other purposes.

A maximum of 20 hp. is required when loading the line, and 15 hp. is required to brake the line when stripping. Water-power under 225-ft. head is used. The power-braking device (Fig. 4) consists of two Pelton water-motors, mounted on a concrete foundation at the

loading-terminal. These motors are standard 24-in. units with the two shafts connected by a rigid coupling, which also serves as a double pulley for driving the two governor oil-pumps. The motors are connected in opposition. The governors are so adjusted that when the speed of the tramway drops below normal, water is admitted to the power-wheel. Should the speed go above normal (the usual tendency) water is admitted into the brake-wheel. As this motor is set in opposition to the power motor, it is obvious that the jet, instead of driving the runner, will be struck by the buckets rotating against the jet. In this manner the excess power of the tramway is absorbed. Direct-motion oil-type governors are used, the pistons of the servo-motors being mounted on an extension of the needle-stems. The speed is kept between the limits of 5% above or below normal speed.

The number of supports required by an aerial tramway depends upon the length and, also, largely upon the nature of the profile of the line. To insure the wearing life of the track-cables, the vertical angles, or curvature, must be limited. Supports of the tower type are ordinarily equipped with cast-iron saddles in which the cables rest and suitable rollers for supporting the traction-rope. In the case of long spans, or where the bend in the track-cable would be excessive with a rigid saddle, so-called compensating saddles are used, each consisting of a pair of saddles mounted on an oscillating beam, which permits the passage of the carriers without undue bending of the cable. Where sudden downward bends occur, supports are used consisting of a series of bents in close proximity, each equipped with saddles, thus dividing the total large bend into a number of slight bends. Where the bend is comparatively great, as in the case of sharp ridges, supporting structures are used in which the cables are overlaid with rails.

At one point in the Spanish Peak line a horizontal bend of 7° is made by means of a couple of supports of special design, the carriers passing through these without detaching from the traction-rope, thus avoiding the usual cumbersome and expensive structure equipped with large sheaves for deflecting the traction-rope, and requiring an attendant to pass the carriers.

There are 65 structures on this line comprising 48 simple tower-supports, as shown in Fig. 3, varying in height from 12 to 55 ft., 8 of which are equipped with compensating saddles, 2 simple angle-stations, 2 two-bent supports, 2 four-bent supports, 4 curved-rail stations, 2 double-anchorage stations, 2 double-tension stations, as shown in the background of Fig. 3, 1 anchorage and tension station, and 2 terminal stations (Fig. 1 and 2). The loading-terminal is also an anchorage-station for the track-cables, and the discharge-terminal is a tension-station for both track and hauling cables. These structures are of timber on concrete foundations. The quantity of timber used was 250,000 ft. B.M., and the quantity of concrete 600 cu. yd. The structure members are all bolted together, and the posts and struts are fastened to the concrete foundations by angle-clips placed on anchor-bolts, these clips being bolted to the timber. The structure members were completely framed and bored at the nearest terminal station, hauled to the site and erected. The foundations are mostly in earth. Four towers and two other structures are founded on rock, a partly decomposed, badly broken, and fissured slate. The slopes were steep, as shown in Fig. 3. The discharge-terminal foundations are in river-gravel. In the design of the foundations, particular attention was paid to local conditions.

The average distance between supports is 410 ft., the maximum span being 2810 ft. The track-cables are of the American Steel & Wire Co. lock-coil construction. These cables are $1\frac{1}{8}$-in. and $\frac{7}{8}$-in. diam. on the loaded and empty sides, respectively. A $\frac{5}{8}$-in. diam., 6 by 7 Lang-lay cable is used for the traction rope. The working tension on the track-cables is 30,000 lb. per sq. in. of metal section. The track-cables are divided into six sections of one mile or less in length, each section being anchored at one end and weighted at the other, a constant tension being maintained in this manner. The traction-rope is a continuous loop over 10 miles long.

The carriers are specially designed for carrying lumber, the essential requirements being that the slings for holding the packages are simple and easily placed, and the loads easily dropped. It was also necessary that the lumber be protected from damage by these slings. The carrier consists of a two-wheel carriage, a rigid hanger pivoted to the carriage to allow free movement in a longitudinal direction, two chains suspended from the hanger and pivoted to allow movement in a transverse direction, these chains in turn suspending a channel-iron bolster. Guards of angle-iron section are placed on the chains, so as to protect the lumber from marring, these guards being free to move on the chain to accommodate a load from 6 to 16 in. high. The chain on one side is fastened to the channel iron-bolster, while that on the other side is made to detach from the bolster by means of a simple catch or latch. The horizontal component of the weight of the lumber, acting through the chains, serves as the only gripping device for holding the load. Two carriers are used for each load. These carriers are independent of each other and are provided with grips for attaching to the traction-rope. The Webber grip is used for this purpose. There are 164 of these carriers, also four 8-cu. ft. ore-buckets and a track-cable oiler. This is about twice as many carriers as would be put on the line at one time.

The packages may be made to contain from 300 to 700 ft. B.M. with almost any end-area dimension up to 12 by 32 in. or 16 by 30 in., and in lengths up to 32 ft. or more (see Fig. 5). The normal package is 512 ft. B.M. These packages are sent out every three minutes, making them 1242 ft. apart on the line.

Eight men are used in the operation of the line, two loaders, two dispatchers, two linemen, and two unloaders. One dispatcher attends to the machinery and equipment and the other keeps the records of loads dispatched, etc. The tramway is equipped with a

FIG. 3 AND 5. TOWER-SUPPORT AND PACKAGE OF LUMBER.

double or metallic-circuit telephone line, telephones being placed at the two terminals and at the principal stations along the line. This telephone system is used for signaling as well as for inter-communication. The telephones are of the Stromberg & Carlson make, with 2500-ohm ringers.

Actual construction required eight and one-half months. The profile survey of the line was completed in October 1915. The position of the structures was

BRAKING DEVICE.

then determined, and the survey of the sites was completed in December. Clearing right-of-way was started in October 1915, and practically completed, except for the burning of 'slashings,' in December 1915. The underbrush and small growth was cleared 25 ft. on each side of the centre-line, and large trees were cleared 10 ft. on each side. All dead, leaning, and otherwise unsafe trees, which could reach the line in falling, were felled. Most of the tower heads were framed between October 1 and December 15. The work was suspended for the winter December 15 and was resumed April 1. Active construction was started May 1, and the line was put in operation September 30, 1916. The design of the special structures and foundations was completed between December 15 and May 1. The dimensions of the 48 tower-substructures and the offset of piers were determined in the field-office; the elevations of the piers were determined graphically from the cable elevations and the cross-sections of the ground; and the offset of piers, lengths of posts, girts, etc., was computed according to the type of structure and the local conditions.

The line was designed and built under the direction of F. C. Carstarphen, tramway engineer for the American Steel & Wire Co. of Trenton, New Jersey. The company furnished the cables, equipment, and all metal parts, with the exception of the power and control unit, which was furnished by the Pelton Water Wheel Co. T. J. Murphy, field engineer for the company, had charge of the erection of cables. I was field engineer in charge for the American Steel & Wire Co., and superintendent of construction for the Spanish Peak Lumber Co. L. T. Hays, F. S. Winslow, and W. B. Sawyer, Jr., of the United States Steel Products Co., of San Francisco, were concerned in the sale of the tramway and took an active interest in the solution of the various field problems. The officials of the Spanish Peak Lumber Co. are O. C. Haslett, president, and D. L. Bliss, Jr., general manager.

CARBONS for diamond-drilling should be selected with care. Those stones, which when examined under a strong glass, have a firm compact appearance, being free from checks, generally prove to be the best. Stones which have a sandy or spongy texture will be found to wear rapidly by abrasion. A set of stones of this latter description was tried and the cost of drilling, for diamonds alone, ran up to $15 per foot. The ground could be driven by hand for $4 per foot, so diamond-drilling was promptly stopped until suitable carbons could be obtained.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

COLEMANITE contains 50.9% of boric acid, 27.2% of lime, and 21.9% water.

EXPORT DUTY on tin ore from the Federated Malay States averages 12% of its gross value.

DRILLING by tripod types of machines at Santa Rita, New Mexico, costs from 32 to 46 cents per foot.

DRILLS should not be allowed to become less than standard gauge, because a hole may be made into which the dynamite cartridge will not enter freely.

COGS are cribs of timber filled with waste rock. They may be erected quickly, have great strength, and are especially useful in preventing an impending squeeze underground.

DREDGING FOR TIN is a success in Siam and the Malay States, but inability to wash thoroughly the clay leads to considerable losses of the cassiterite. Clay also reduces the digging capacity.

ORE CLASSIFICATION by the Chino Copper Co. has the following designations: 0.00 to 0.79%, poor; 0.80 to 0.89%, low No. 1; 0.90 to 0.99%, low No. 2; 1 to 1.24%, fair; 1.25 to 1.49%, good; 1.50 to 1.99%, excellent; and 2% upward, superlative.

A SQUEEZE is defined in Pennsylvania as being caused by the general subsidence of the strata overlying a coal-bed or ore deposit, due to part failure of the pillars. When this subsidence radiates from origin it is called a creep. Another meaning of creep is movement of the floor, due to pressure of pillars.

PYRRHOTITE is the mono-sulphide of iron. It is usually slightly magnetic and occasionally contains nickel. In Californian mines in granite it is often the principal sulphide in the ore. Pyrrhotite also is abundant in most of the copper mines of the Pacific Coast where large bodies of massive sulphide are mined.

CONCRETE RETORTS are now being used in the manufacture of the pine-oils made by destructive distillation. The use of such retorts permits the production of an oil containing only a minimum proportion of pitch, which is drawn from the bottom of the apparatus. Such oil, low in pitch, is a good frother and does not lift the gangue.

THE STRIKE of a vein or formation is always at right-angles to the dip. If the dip is known and stated, it seems unnecessary to give the strike also, which is often awkwardly expressed, as "the strike is north-west and south-east, with a dip to the north-west." If the dip is described as north-west then it is known at once that the strike, being at right angles to this, must be north-east.

SAMPLES of copper ore at Santa Rita, New Mexico, are of four kinds, taken concurrently, namely: prospect-hole samples, pit samples, car and steam-shovel samples, and blast-hole samples. An average of 2400 assays and determinations is made each month, costing from 42 to 86c. per assay.

GOLD from the gravel of Manhattan gulch, Nevada, had the following fineness during the past 6 years: 703, 709, 706, 716, 721, and 731. This regular increase toward the mouth of the gulch is thought to be due to the solution, through long action of the surface water, of part of the silver and nearly all of the base metal contained in the gold.

ALUMINUM possesses to a high degree the ability to remove traces of oxygen from steel, small quantities, 0.05%, 'killing' the steel. In itself, it is a more efficient de-oxidizer than manganese or silicon, but when considered as the sole means of de-oxidizing the steel rather than as an ingredient to be used for removing the last traces of gases, there are objections to its use.

MANGANESE added to steel acts as a carburizer or a de-oxidizer. These functions may be classified as follows: In foundry practice: (1) Its use as a de-oxidizer and de-sulphurizer; and (2) its use to alter the constitution of grain in the metal. In steel-works practice: (1) Its use as a de-oxidizer; and (2) its use to impart certain static properties to steel.

IN MINING under lakes, reservoirs, rivers, or the sea, the following conditions must be considered: (1) The character of the overlying strata, with special reference to loose deposits of alluvium or beds of clay between the bottom of the water and ore deposit; (2) the presence of faults and dikes in the strata; (3) the dimensions of pillars to be left and the width of openings to be made; and (4) the necessity of leaving ore next to the roof in some cases.

WEIGHT of rocks is frequently discussed, so the following table should be worth study:

Rock	Average specific gravity	Weight, pounds per cubic foot	Cubic feet in short ton
Andesite	2.9	181.0	11.1
Basalt	2.9	181.0	11.1
Diabase	3.0	187.0	10.6
Diorite	3.0	187.0	10.6
Granite	2.7	168.0	11.9
Limestone	2.7	168.0	11.9
Porphyry	2.7	170.0	11.8
Quartz	2.6	162.1	12.3
Rhyolite	2.4	149.6	13.4
Sandstone	2.4	149.6	13.4
Schist	2.7	168.0	11.9
Shale	2.6	162.1	12.3

Diamonds in California

By W. H. Storms

The occasionally reported discovery of diamonds in the gold-bearing gravel mines of California, recalls to mind the fact that diamonds have frequently been found at a number of localities in the State, though, thus far, none have been found anywhere but in the gravels of streams, either ancient or recent; that is, no diamonds have been found in the solid rock in California. In nearly all of the districts of California where diamonds have been discovered, serpentine, or gabbro, or some other kind of rock rich in olivine, or an alteration product of it, occurs in the vicinity where the diamonds have been found, or at some place higher up on the same stream.

Diamonds were reported in California as early as 1850, and although the total number that has been discovered is large, probably several hundred, it is not unlikely that as great a number, or even more, has been lost through the failure of the placer miners to recognize the stones when cleaning-up their rockers or sluices. The concentrated material taken from the boxes contains a great number of pebbles of various colors, having usually a greater or less degree of transparency, and to the miners these little pebbles are of small value, and are thrown away. It is the gold they are seeking, and the discovery and recognition of a diamond is more likely to be the result of accident than anything else. In Butte county, in the vicinity of Oroville, the placer miners have long since realized that it is possible to find diamonds in cleaning-up and consequently they are on the lookout for them, but in other diggings the men are usually less alert, and diamonds are more than likely to be overlooked, and thrown out with the common pebbles that are so abundant in the placer mines. These pebbles are most commonly garnet, peridot (olivine), zircon, magnetite, chromic iron, quartz crystals, and numerous others, all of which collect in the sluices, or rockers, and are eventually transferred to the miner's pan when cleaning-up, so he, at least, has a good chance to detect the presence of diamonds should any be present.

H. W. Turner gives the following localities in which diamonds have been found in California: (American Geologist, Vol. 23, 1899). In Eldorado county, at Placerville, on the south side of Webber hill, in White Rock canyon, at Dirty Flat, and at Smith's Flat; in Amador county, at Rancheria, three miles south of Volcano, and at Loafer Hill, near Oleta; in Nevada county, at French Corral; in Butte county, at Cherokee Flat and at Yankee Hill; in Plumas county, at Gopher Hill, and on upper Spanish creek. It is reported that diamonds have been found also in Del Norte, Trinity, and Tulare counties, in this State.

One of the first diamonds found at Dirty Flat, near Placerville, measured, according to W. A. Goodyear, (Fourth Report State Mineralogist), nine thirty-seconds of an inch in maximum diameter, and weighed 1¼ carat. Several diamonds were found on the south side of Webber Hill.

Mr. Goodyear says he found itacolumite, a variety of micaceous sandstone, remarkable for its flexibility, three miles east of Placerville, in a locality where diamonds had been discovered. In Calaveras county I found itacolumite in the wash of the Happy Valley hydraulic mine, a mile east of the village of Mokelumne Hill, but I found no diamonds there, nor did I hear of any ever having been found in that channel. Itacolumite is of common occurrence in the diamond regions of Brazil, and some have thought that wherever this flexible sandstone occurs, there diamonds also should be found. This belief is, perhaps, natural and yet no diamonds have ever been reported as having been found imbedded in the itacolumite, at least not so far as I have ever heard. It seems that the flexible sandstone is merely associated with diamonds in several localities, but is not what may be termed the matrix of the precious stones.

As early as 1854 Melville Atwood, an English mining engineer, wrote an article on placer mining in California that was published in a San Francisco newspaper, in which he said: "I desire to call attention to the chance of finding diamonds in this country, and the likelihood of their being overlooked. The rocks in which they occur are common in California. Itacolumite, a soft micaceous sandstone, always the associate of diamonds, is also found here. The gravel always found in the river washings so closely resembles the 'cascalho' or diamond gravel of Brazil, that I think it very probable that if the proper search be made diamonds will be found."

It should be noted that diamonds had been found in California prior to this intimation of Mr. Atwood, that they might be discovered in California, though he might not have been acquainted with that fact.

As far as I have learned, all the diamonds that have ever been discovered embedded in their natural matrix, have been found in dark, basic rocks of the peridotite group. The diamond-bearing ground of the South African mines is what is known as kimberlite, a compound of olivine and augite, usually more or less serpentinized and otherwise altered. In Butte county, California, where numerous diamonds have been discovered, is a dark green much altered rock, which seems to have been originally diabase, or some similar rock, and, although at a casual glance it might be mistaken for kimberlite, this similarity, on close inspection, is seen to be no more than a resemblance to the kimberlite of Kimberley and other South African diamond localities.

Concerning this so-called kimberlite near Oroville, D.

B. Sterrett said, in 'Mineral Resources of the United States,' 1906: "The specimens sent to the Survey as typical 'blue-earth' of the Oroville locality, do not bear much resemblance to the genuine kimberlite of South Africa. Points of likeness are the extensive serpentinization in each, a general bluish-green color, and the probable brecciation of the California rock compared with the evident extreme brecciation of the kimberlite. On the other hand, the general appearance of the two rocks on close inspection is very unlike. The California serpentine apparently does not contain inclusions of other types of rocks forming the walls, while the kimberlite contains these in quantity, as black shale, conglomerate, quartzite, melaphyre, etc. The numerous plates of biotite, common in the true kimberlite were not observed in the California rock. The presence of feldspathic material in the California serpentine indicates a quite different type of rock from the kimberlite. The latter is regarded as a serpentinized volcanic peridotite breccia, with the serpentine probably derived from a less basic rock, possibly of the gabbro or diorite class. As far as can be learned, the presence of 'bulls-eyes' (spherical balls with concentric layer structure, and concretions or nodules of calcium carbonate), is not a prominent feature of the South African diamond mines, while the occurrence of lime concretions is not limited to the outcrop of diamond pipes alone, but is common to large areas of country around Kimberley, where rocks other than kimberlite outcrop. It seems probable that the outcrop of rock near Oroville, designated as 'kimberlite' by the owner of one of the mines where diamonds have been found, is a portion of one of the belts of serpentinized amphibolite schist running through the country, in a north-west direction. * * * The alluvium has been washed off (by hydraulicking), exposing a portion of such a belt, which has been mistaken for a pipe formation, since it is exposed over a limited area. The rock formation, including the region a mile north of Oroville, represents a highly metamorphosed series of basic rocks which have yielded amphibolite schist and serpentine. In this formation are included diabase-porphyrite which would readily furnish such specimens as the 'bulls-eyes' above described. Many authenticated finds of diamonds are on record in Butte county. Some of them have been along Feather river not very far from Oroville. The majority of them have come from Cherokee Flat, north of Oroville, where a company has been formed to prospect for diamonds. Since the presence of diamonds is well established for this part of California, it remains for some one to locate them in the matrix. Just what the nature of that matrix will be is not known. It may not be a typical kimberlite rock and in the form of a volcanic rock, but one of the other varieties of basic igneous rocks so plentiful in this region. It has not been proved that a kimberlite formation is essential to the occurrence of diamonds, nor that where such rock exists it must carry diamonds. Several rock outcrops are known, as in Elliott county, Kentucky, and Kakanui, New Zealand, where there are basic rocks almost identical in appearance to kimberlite around which no diamonds have as yet been found. On the other hand, diamonds occur in a matrix of hornblende-diabase near Inverell, Australia. Since the composition of many of the rocks of the Oroville region is not very unlike this, it may be that the diamonds will some day be found in a matrix of similar type in that region."

Henry G. Hanks, the first State mineralogist of California, in his fourth report, says that diamonds were found at Cherokee Flat, in Butte county, in 1853, and that the largest weighed two and a quarter carats. The diamonds discovered in the Cherokee diggings were rose colored and yellow, or colorless, and all were associated with zircon, platinum, iridium, magnetite, gold and olivine. Microscopic diamonds have been found in a score of places in northern California and in Oregon, but these are, of course, of mineralogical interest only, still a careful search might discover larger stones of value.

Nearly all of the diamonds thus far found in California have curved faces, some of them being almost round, with only a rough approximation to the octahedral form, or some modification of it. The rough diamond has a most peculiar lustre, and one difficult to describe. In the text books this lustre is called 'adamantine' but to get an idea of what adamantine lustre really is like, it is necessary to see a rough diamond. I have had the good fortune to see a number of rough diamonds, both colorless and those having faint shades of color, though principally yellowish. The most of them looked like colorless bits of glass, and would fail to impress the average finder as a stone having value. Some of them, though not all, possessed the adamantine lustre, others showed but little of it. Some of them looked to me like crystals that had been treated to a very thin coat of ordinary stove-polish, and I can think of nothing that will give a better idea of what adamantine lustre is like than this thin film of stove-polish, without actually seeing it in the diamond itself.

There was at one time on exhibition at the State Mining Bureau, in San Francisco, a beautiful diamond owned by the late Jacob Z. Davis. It was found at Volcano, Amador county, and was an almost perfect octahedron, colorless and with only one or two small flaws. This stone was probably the finest diamond thus far found in California, and was valued at $500, not that it was a large diamond, for it was not, but because of its unusual beauty and the rarity of crystallization. This diamond weighed 1.57 carat. It is thus described by Geo. F. Kunz, gem expert, in Bulletin 37 of the California State Mining Bureau, page 40:

"It is a modified octahedron, about $\frac{8}{10}$ inch diameter, transparent and nearly colorless, though slightly flawed. The curvature of the faces gives the crystal a sub-spherical form, but the edges of the pyramids are channels instead of planes. Closer examination shows that the channeled edges, the convex faces, and the solid angles are caused by an apparently secondary building up of the faces of a perfect octahedron; and for the same reason the girdle is not a perfect square, but has a somewhat

circular form. These observations were well shown by enlarged drawings. The faces seem to be composed of thin plates overlying each other, each slightly smaller than the last. These plates are triangular, but the lines forming the triangles are curved, and the edges of the plates are beveled. Under the microscope it could be seen that each triangular plate was composed of three smaller triangles and that all the lines were sligthly curved. The building up of plate upon plate caused the channeled edges and the somewhat globular form of this exquisite crystal. A close inspection revealed tetrahedral impressions, as if the corners of minute cubes had been imprinted on the surface of the crystal while in a plastic state. These are the result of the law of crystallization, as shown by the faint lines forming a lace-work of tiny triangles on the faces when the stone was placed in proper light."

Diamonds possess some remarkable physical properties which serve to distinguish them from all other minerals. The most prominent feature is extreme hardness, it being the hardest known substance. It can be easily broken however, as it is extremely brittle. Owing to its cleavage, lapidaries are enabled to split off slices or fragments with comparative ease, by simply placing a knife blade at the right spot and striking it a light blow with a small hammer. When diamonds are to be split in this manner they are first partly embedded in cement so that they may be firmly held while undergoing this delicate operation. When a diamond is exposed for some minutes to the direct rays of the sun and then taken into a dark place it emits a phosphorescent light that continues for several minutes, gradually becoming more dim until the light disappears. When rubbed the diamond becomes positively electric. It is not in the least affected by acids or alkalies, and although under proper conditions it will burn, it can withstand a very high temperature without being visibly affected. The heat of an ordinary blow-pipe flame has not the slightest effect on it, but in a muffle it is stated that the diamond burns at about the temperature of the melting-point of silver, though it can be highly heated in a closed crucible without any effect upon it whatever. Diamonds have a wide range of color, being colorless, red, rose, green, blue, yellow, brown, and black. It is found in many shades of these several colors, of which the most valuable stones are those having decided colors, the faintly tinted ones being much less esteemed than those that are free from color. Some years ago several sharp fellows secured a number of pale yellow diamonds that were otherwise perfect. These diamonds they dipped in a solution of purple analine dye, the effect of which was to give the stones a most beautiful delicate bluish tint, which at that time was considered the acme of perfection in the diamond. They succeeded in disposing of the treated stones at fancy prices and the trick escaped detection for some time—until one of the purchasers chanced to wash his hands with soap and water while wearing the 'doctored' ring, when the analine dye was at once removed exposing the deception.

The diamond feels cold to the touch, and when breathed upon becomes covered with a thin film of moisture in the same way that a cold window pane is dulled when breathed upon. It is said that when the lustre of the diamond is thus momentarily dimmed, if there are any flaws in it they can be detected easily in this manner, as they then become more apparent.

Perhaps the most curious property of the diamond is that which was accidentally discovered by a man named Kersten while engaged at the sorting-table of one of the South African diamond concentrators. He had before him a miscellaneous lot of stones—diamonds, zircons, peridots, garnets, and various others, such as are constantly recovered from the concentrators. Requiring more room on the table for some purpose, he brushed the stones aside, when a number of them rolled up onto a board on which there was a quantity of tallow. As the board chanced to be lying in an inclined position all of the stones rolled back upon the table except the diamonds which remained adhering to the tallow. Kersten, being an observing fellow, noticed this strange fact, but thought it might be due to chance. He repeated the operation to see if it would by chance happen again, and then made the remarkable discovery that it did. Time and again he tried the experiment, and always with the same result—the diamonds adhered to the tallow while all stones other than diamonds rolled down the board onto the table. Realizing that he had made a valuable discovery, he applied for and obtained a patent for the idea, which he sold to the DeBeers company for a substantial price. This device at once did away with the necessity of hand-sorting the diamonds from the other stones with which they are always associated in the concentrate from the South African mines.

In consideration of this remarkable property of the diamond to adhere to a surface of tallow, it has been suggested by Geo. F. Kuntz that it might be a good idea to equip the mines in the diamond districts of California with these tallowed boards, where, if diamonds be present in the concentrate they would all be recovered if the concentrated sand be passed over one of these boards. I do not know of this experiment having been tried at any California placer mine or on any dredge, but the suggestion seems to be one worth trying, as it costs nothing and might result in the recovery of numerous small diamonds, to say nothing of larger ones. I think it would be an excellent idea to make the experiment.

Besides those in California, diamonds have been found in the United States in North Carolina, Virginia, Alabama, Wisconsin, Michigan, Indiana, Arkansas, and Ohio. The only real diamond mines in the United States, however, are in Arkansas, where there are several peridotite areas in which diamonds have been discovered, and a number of companies have been formed to explore for the precious stones. A great many diamonds have been found in these various mines and among them some fine ones, of rare shades and great brilliance. These mines are in the vicinity of Murfreesboro, but the industry has not as yet made great strides in a commercial way, though its future is by no means without promise.

Molybdenum Ores and Their Concentration

By F. W. Horton

*Although there are large deposits of low-grade molybdenum ore in the United States, and a latent market for the metal, until recently there has been little development of these deposits. A deterrent against their exploitation was the lack of any considerable demand for molybdenum. Makers of alloy-steels feared that they would not be able to get a steady supply of the metal; while, on the other hand, owners of molybdenite deposits thought that any large production of the mineral would glut the market. These two main factors depressed a market that had to be developed. Mining was by small-scale operations on high-grade ore. The U. S. Bureau of Mines therefore investigated the character and extent of the deposits of molybdenum, and how the ores might best be concentrated into a marketable product. The War has stimulated the demand for molybdenum throughout the world, but the high prices now being paid cannot last, although under normal conditions the metal should be able to compete with tungsten.

The molybdenum minerals are as follows:

Mineral and composition.	Molybdenum, %
Molybdenite, MoS_2	59.95
Wulfenite, $PbMoO_4$	26.15
Molybdite, $Fe_2O_3.3MoO_3.7\frac{1}{2}H_2O$	39.63
Ilsemannite, $MoO_2.4MoO_3$(?)	68.18
Belonesite, $MgMoO_4$	52.08
Powellite, $CaMoO_4$	49.98
Pateraite, $CoMoO_4$	43.84
Achrematite, $3(Pb_3As_2O_8PbCl_2)_4 = (Pb_2MoO_5)$	3.40
Eosite, Vanado-molybdenite of lead	....

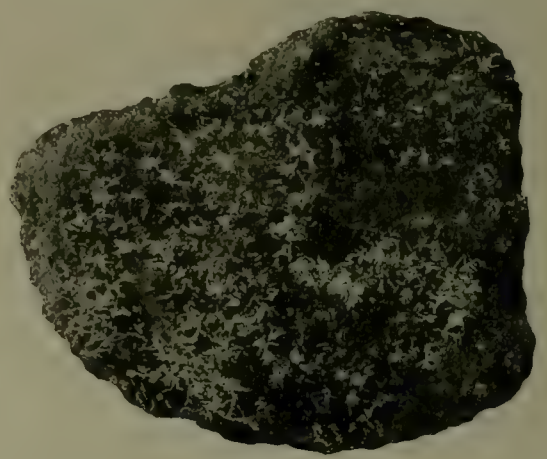
Only molybdenite and wulfenite are of commercial importance, the others being rare, save molybdite. Molybdenite is a soft, opaque, lead-gray mineral with a metallic lustre and greasy feel, commonly occurring in flakes or scales. Finely granular and massive forms are also common. The mineral is soft, and marks paper. Its hardness is 1 to 1.5, and specific gravity 4.7. Molybdenite is often confused with graphite, which has similar characteristics, but has a specific gravity of 2.09 to 2.23. A heat test of molybdenite gives off sulphur, graphite will not.

Probably 75% of the reported occurrences of molybdenite are in acid-igneous rocks such as granites, pegmatites, trachytes, and syenites; next in order are the metamorphic rocks such as serpentines, gneisses, amphibolite, chlorite, talc, and mica-schists; then sedimentary rocks such as conglomerates and limestones; finally in basic-igneous rocks.

Wulfenite is a molybdate of lead, containing 26.15% molybdenum and 56.42% lead. It is heavy (specific gravity 6.7 to 7), brittle, has hardness of 2.75 to 3, and is generally orange-yellow color. It frequently occurs in well-crystallized forms, but is also found in coarse-grained or fine-grained masses. When heated with soda on charcoal it yields metallic lead. Deposits are almost wholly confined to veins, associated with other lead minerals.

The American occurrences of molybdenum minerals may be briefly described as follows:

In Arizona there are many deposits of molybdenite and wulfenite, and save Nevada is the only State in which is any large quantity of the latter mineral. In fact, this ore supplied most of the molybdenum of the United States in 1915. Wulfenite deposits of Arizona are mostly in Cochise, Pima, Pinal, and Yuma counties, in the south. Molybdenite is found in Greenlee, Mohave, Pima, Pinal, and Santa Cruz counties, but is associated with copper minerals, making separation somewhat troublesome. The Mammoth, Collins, Old Yuma, and other mines are described. The first was operated for gold ore, and the tailing is being treated for its wulfenite-content.



SECTION OF TYPICAL MOLYBDENITE ORE FROM THE LEADER MINE, HELVETIA, ARIZONA. NATURAL SIZE.

Molybdenite is widely distributed in California, 41 occurrences in 16 counties. Forty miles east of San Diego is the property of the Santa Maria Molybdenum M. & M. Co. The molybdenite deposit consists of a large granite dike from 35 to 100 ft. wide. The mineral occurs sparingly throughout the granite in crystal aggregates and irregularly-shaped masses of radial structure. Other deposits near Bishop, Kearney Park, Corona, and Caliente are briefly described.

In Colorado molybdenite is widely distributed in al-

*Abstract from Bulletin 111 (132 pages), U. S. Bureau of Mines.

most every mountain county. Near Empire in Clear Creek county, the Primos Chemical Co. is mining three veins of low-grade ore. This occurs as an alaskite (?) breccia, in which the molybdenite appears as occasional small flakes, but oftener in finely-granular form associated with iron pyrite in the interstices of the breccia; also in small veinlets running off into the alaskite—porphyry (?) country. Production to date is between 1500 and 2000 tons of 2% ore. Eleven miles south-west of Breckenridge is an interesting deposit of molybdenite in two pegmatite veins.

In Montana there are over a dozen occurrences of molybdenum ore. At the Great Western M. & M. Co.'s mine in Park county, 10 miles from Emigrant, the nearest point on the Yellowstone Park railway branch, a mill, employing flotation, was to be built during the writer's visit. At other Montana mines the amount of development done is small.

In New Mexico molybdenite is found with copper minerals in San Miguel, Rio Arriba, and Grant counties; also with lead and silver ore at Organ, Dona Ana county. Wulfenite is found almost entirely in Dona Ana, Sierra, and Grant counties, rather commonly with silver ore in Dona Ana.

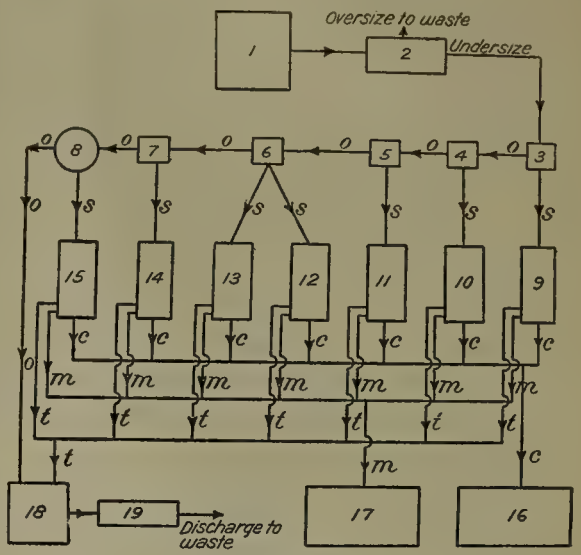
In Washington there are some interesting deposits in Chelan and Okanogan counties. At the Crown Point mine the mineral is in white vitreous quartz in fine specks to large pieces.

One of the best and most-easily applied qualitative tests for molybdenum is made by treating the finely-powdered ore with 5 cc. of concentrated nitric acid, evaporating to dryness, treating the residue with ½ cc. of concentrated sulphuric acid, and again evaporating to dryness. If molybdenum is present a beautiful ultramarine blue color develops in the residue on standing from 2 to 12 hours. Other tests are given, including the Bureau of Mines quantitative method.

Outside of a small and irregular production of wulfenite concentrates the molybdenum markets of the world have been supplied largely by a product containing 50 to 90% MoS_2, obtained by primitive methods. Successful concentration of the ores containing from 1 to 3% MoS_2 is the main factor on which the future of molybdenum mining depends. Mechanical concentration so far is economically superior to other treatment methods. Wulfenite is amenable to jig and table treatment; molybdenite is not, owing to its flaky character. Many plants erected to concentrate MoS_2 have been failures, the processes not being suited to the ores. Methods that have been successfully used may be grouped as (1) rolling and screening, (2) electrostatic, and (3) flotation. A brief discussion of these follows:

1. When the MoS_2 occurs as large flakes or crystal aggregates it may be recovered by crushing the ore in rolls, followed by screening the fine material. The success of this method depends on flattening the MoS_2 masses into flakes the largest diameters of which are greater than those of the particles of gangue. The work may be done in series. This treatment is not efficient, and may be classed as a preliminary to other processes. Ores containing mica are unsuited to rolling and screening.

2. Molybdenite is a good conductor of electricity, and may be separated from most gangue minerals found with it by electrostatic methods. For this treatment the favorable class of ore is that in which the MoS_2 is flaky and of good size, and where the gangue is clean quartz, granite, etc. The ore must be perfectly dry and warm. Material as fine as 200-mesh and as coarse as 6-mesh may



FLOW-SHEET OF BOYKIN & HEREFORD WULFENITE MILL AT MAMMOTH, ARIZONA.

(1) 40-ton ore-bin; (2) inclined 4-mesh screen; (3 to 7) hindered-settling classifiers; (8) settling-cone; (9 to 11) Overstrom tables; (12) Ludwig table; (13 to 15) Card tables; (16) concentrate storage; (17) middling storage; (18) tailing-pump; (19) Byron Jackson 3-in. 'dreadnaught' sand-pump; c = concentrate; m = middling; t = tailing or residue.

be treated, but the coarse product gives best results. Tests made by the Santa Maria Molybdenum M. & M. Co. of San Diego, California, on an iron-stained granite containing 0.5% MoS_2, gave 83.68% recovery by electrostatic separation. The concentrate assayed 72.42%, middling 26.9%, and tailing 0.2% MoS_2. At present there are no plants treating MoS_2 ore commercially by such methods. Costs should not be any greater than in treating zinc ore by similar processes, say $2.50 to $3.50 per ton.

3. Molybdenite, like most metallic sulphides, is not wetted readily by water, floats on water when dry, and is easily wetted by most oils. Water flotation of MoS_2 ore is simple, and does not necessarily involve the use of oil, acid, or gas. The ore is fed as thin as sheet and at as uniform a rate as possible onto a moving water surface in a tank. The Wood (Denver) machine is the best known of this type. Twenty to forty-mesh ore is a good size for this process. Generally speaking, oil flotation probably offers the best method of treating MoS_2 ores, in which the mineral is flaky. Oil-flotation processes are

applicable to a wider range of sizes than are electrostatic or water-flotation methods. In Norway the Elmore vacuum-flotation system is treating successfully MoS_2 ore. Both electrostatic and flotation methods make a product that contains pyrite and other sulphides, which are objectionable, and must be separated from the MoS_2 to yield a marketable product.

Treatment of wulfenite ore presents few problems, the usual concentrating machines recovering a high percentage of the mineral. The finest particles of the $PbMoO_4$ are readily wetted, hence sliming does not result in the large losses made in treating various metallic sulphides under similar conditions. Wulfenite can be treated successfully by pneumatic methods also. At the Mammoth mine, 3 miles from Schultz, Pinal county, Arizona, Boykin & Hereford are treating over 200,000 tons of tailing from an old cyanide plant, which contain from 1 to 2% wulfenite. The scheme of operations is clearly shown in the accompanying diagram. The cost of scraping the tailing and delivering it into the plant is 14c. per ton. From 200 tons of tailing treated daily 2 tons of concentrate is recovered. This contains 22.62% MoO_3, and 61.83% PbO.

The Miner's Creed

Following is a Butte miner's creed. It is good enough for miners elsewhere.

Bar down all loose ground before starting to do any other work;

Never leave candles burning on timber;

See that the grizzlies over chutes are in good repair;

Be careful around electric wiring and all electric apparatus;

Never drill alongside a missed hole;

Cut out all fooling while at work, and also rushing for cage at quitting time;

Keep the stope-floors in good repair and tidy;

Never carry powder with a capped fuse;

Give warning in ALL directions when blasting;

Bend down nails in all boards or lagging that may be lying around where men may step on them;

Keep the guard rails in place on all manways;

Never use a drill or metal bar in tamping;

Get all wounds properly treated so as not to risk infection;

Warn and help new men to protect themselves from injury by accident.

COAL-MINE FATALITIES in the United States during 1916 decreased 3% from the 1915 total. Coal production increased 12%, the output being 597,000,000 tons. The fatality rate was 3.09 per 1000 men employed. The general results show that the efforts exerted by the various agencies whose object is to reduce mine accidents are meeting with success. Among the means employed to reduce accidents may be mentioned the general use of safety-lamps in doubtful mines, the introduction of permissible explosives, humidifying dusty mines, first-aid and rescue-training which save lives that might otherwise be lost by reason of injuries received, the enactment of industrial accident compensation laws, and the spirit of co-operation on the part of all concerned.

Introducing Coal Into Blast-Furnace Through Tuyeres

*It is the practice in Japan to introduce soft bituminous coal continuously into the blast-furnace through tuyeres. The coal-charging device is a cylinder of 3-in. inner diameter and 13 in. long, provided with a piston worked by a rod having a handle at the outer end. The coal is in lumps of ½ to 1½ inches. After it is filled with coal, the implement is thrust rapidly into the tuyere and the contents discharged by pushing the handle operating the piston. The contents of three or four cylinders are inserted into one tuyere at a time, and take about 10 to 15 minutes to burn out. It is necessary to use a poking-rod through the tuyere-hole to clear the tuyere and get all the coal into the furnace.

We have recently used the tuyere-coal with splendid results in a blast-furnace 11 ft. by 39½ in. and 8 ft. high from the tuyere-centres to charging-floor. The height of the jacket is 4 ft. The blast-pressure is 1 lb. When 7.5% coke is used in the usual way, the furnace smelts 121 tons total charge per day, or 3.3 tons per sq. ft. of tuyere-level area. On the other hand, when 1.2 tons of coal per day is introduced through the tuyeres, the total charge is increased to 154 tons (4.3 tons per sq. ft.), the coke is decreased to 5.9%, and the limestone is reduced by 3%. Generally two workmen are added per shift when the tuyere-coal is used. The direct cost is reduced by 17%. Even if two workers are added per shift, the cost still remains 15% smaller. The splendid results obtained by using pulverized coal in reverberatory furnaces immediately suggested to us the use of pulverized coal instead of lumps for this special purpose, and experiments are now in progress with good results.

New Geological Map of California

A new geological map of California has been issued by the State Mining Bureau. The map has been compiled from data obtained from numerous official maps and sources of information, and in part by personal investigation by qualified geologists. It is a vast improvement over any previous general geological map of the State, and is as detailed as it is practicable to make a map on so small a scale—12 miles to the inch. It will be of value to all engaged in geological study of California. Besides the geology, there is delineated on the map what is known as culture, that is, railroads, highways, pipe-lines, power-transmission lines, and canals.

*Communicated by Furukawa & Co., Ashio, Japan.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

RICH ORE FOUND IN IOWA GULCH DISTRICT.

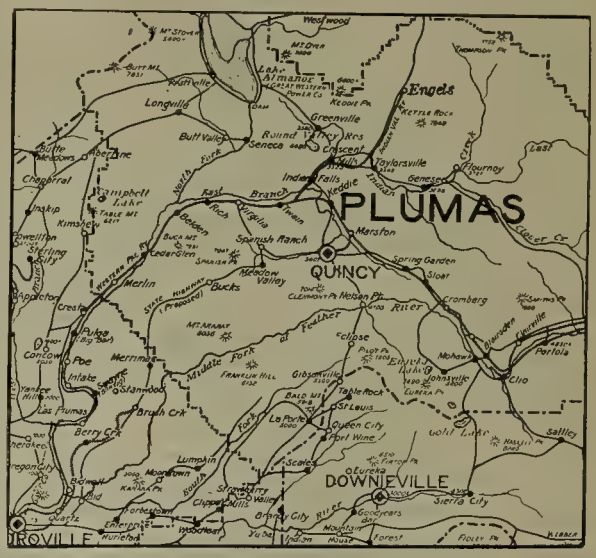
Another rich discovery, the largest in the district for 10 years, has just been made by the Ontario, Tiger, and Green Mountain Leasing Co. at the Ontario tunnel, near the head of Iowa gulch. A 4½-ft. vein, assaying from $20 to $40 per ton, has been cut in the adit at a distance of 703 ft. from the portal. Development that has been accomplished so far has exposed the ore for 14 ft. on a face 7 ft. high. The ore continues both above and below the adit-level. At a point where the ore was found, the adit is 580 ft. below the surface, and the breast is at least 1300 ft. from the nearest workings. The metal-contents are lead, gold, silver, and copper. The presence of a rich vein in the Tiger and Green Mountain claims has been known by a number of the present lessees for several years. In 1878 the vein was discovered near the surface on the sites of the Tiger and Green Mountain shafts, and it is stated that $80,000 was extracted in a short time. Water caused the property to be abandoned, as it was impossible to drain with the facilities then available. Hoisting was done by means of a whim. In 1903, the property was reopened by E. A. Smith, organizer of the present leasing company. He installed pumping-machinery, but the flow was too strong to handle. An adit-level was started later, and the Ontario was driven from the bottom of the gulch a total distance of 300 ft., where, for some unknown reason, work was stopped. The Ontario was re-opened late last year when E. A. Smith and Hector McDonald, well-known Leadville men, secured a lease on 60 acres of territory including the Ontario, Tiger, and Green Mountain properties. A contract was let for extending the adit 800 ft., a distance that was calculated to bring the breast under the Green Mountain shaft. Half of this distance was completed when the ore was encountered. It is thought that the rich ore will continue in the vein to the shaft, which is 400 ft. ahead, and is expected to extend to the Sunday line bounding the property on the north. The trend of the vein is north-east in a direct line toward Breece hill and the Ibex mine. It is reported that the vein may be the southern extension of one of the large oreshoots opened in the Ibex. There is a noticeable stir among local mining men since the announcement of the discovery. The County Treasurer is receiving many enquiries by men examining tax-records on all available ground in the Iowa Gulch district. Prospecting is expected to be undertaken on numerous properties as soon as the snow has melted. Iowa gulch, while it was one of the rich parts of early-day operations, has been developed on a meager scale, and it might be stated correctly that the area is practically new. Undoubtedly other rich veins exist in the ground. Shareholders of the Ontario, Tiger, and Green Mountain Leasing Co., are all local mining and business men. They are: Alfred Hoffman, Arthur Lumsden, J. H. Fiske, T. D. Kyle, Ike L. Jones, E. A. Smith, Hector McDonald, Otto Thurn, Paddy Connors, W. G. Collins, Arthur Dalrymple, J. B. Jackett, and N. Nyboe.

The Greenback shaft has been unwatered to the bottom, or 1350-ft. depth. The present flow of water is 500 gal. per minute.——Fanny Rawlins on Breece hill is yielding over 2 oz. gold ore, also some copper.——In spite of the snow the Kokomo-Robinson district gains in activity. At the Golden Queen in this district 8 ft. of lead-zinc-silver ore has been opened.

ENGELS, CALIFORNIA

COPPER MINING IN PLUMAS COUNTY.

During the past two years Plumas has become one of the leading copper-producing counties of California, Shasta leading with over 40,000,000 lb., Calaveras with over 4,000,000 lb., and Plumas with over 4,000,000 lb. Lack of adequate transportation has been the principal cause against rapid development of the region, but through the efforts of the Engels Copper Co. the Indian Valley railroad has been completed from Keddie, on the Western Pacific, to Crescent Mills, and will reach the Engels mine in the early spring. It is reported that a branch will be extended to Genessee and that another line has been projected that will serve the Walker mine and



MAP OF PLUMAS COUNTY, CALIFORNIA, PREPARED BY STATE MINING BUREAU.

other properties in the vicinity of Portola, a thriving town on the Western Pacific railway.

The prominent mines on the Plumas copper belt are now in the hands of strong corporations, insuring their economical and thorough development. The Walker mine, 20 miles east of Portola, is controlled by the International Smelting Co., and most of the territory located between the Walker and Engels mines recently passed under option to the United States Smelting, Refining & Mining Co. This corporation has installed equipment on the Five Bears, Iron Dyke, Eagle Hill, and other properties, and plans thorough development with the passing of winter. The Walker interests of Salt Lake City, connected with the Walker mine, are working the Bonita, a nearby property, and have other holdings under bond. The International Smelting interests are exploring the Green Ledge, Tutt, and other groups. Several Eastern companies have representatives in the field. Most of the copper ore contains good gold and silver-content. It is ideal for treatment by flotation.

The Walker mine is among the most interesting properties

in the county. It has been developed from a prospect to a producer in approximately three years, during which time litigation hampered work, and low copper prices discouraged financing of the enterprise. Taken over from local people of limited means by J. F. Cowan and the Walker Bros. of Salt Lake City, the mine was opened by a shallow shaft, several adits and cross-cuts, and prospected with diamond-drills. Encouraged by results, a flotation plant of 100-ton capacity was erected in 1916. In the fall of last year the mine passed to control of the International interests. The group contains 34 heavily-timbered claims, and the ore is moved from the shaft to the mill by a Leschen aerial tram 4200 ft. long, with a capacity of 250 tons in 16 hours. The tram operates by gravity, the plant lying 800 ft. below the mine ore-bins. Direct flotation is employed. An Allis-Chalmers jaw-crusher and ball-mill deliver pulp to Dorr classifiers, Callow cones and cells, and an Oliver filter. At present the plant is treating 75 tons of ore daily. Concentrate is shipped to the Tooele smelter at International, Utah. It is understood that the company proposes to increase the capacity of the plant in the coming summer, and to develop the mine more vigorously. V. S. Hart is manager.

COBALT, ONTARIO

SILVER FOUND IN THE LOWER CONTACT.

The new silver vein recently discovered just below the lower contact in the Beaver Consolidated is 8 in. wide and averages 2000 oz. per ton. In addition to a large amount of high-grade ore, the wall-rock contains $75 per ton. In all there is nearly 7 ft. of high-grade ore. After mining for the past 10 years in the Keewatin formation, which overlies the diabase to a depth of approximately 500 ft. in that part of the Cobalt silver area, and after paying on an average of $6000 monthly dividends for these ten years, the Beaver was generally thought to be nearing the end of its reserves. However, after a preliminary diamond-drilling, which determined the underlying diabase sill to be 1000 ft. thick, the management decided to sink through this sill and explore the underlying Keewatin. Accordingly in July last the main shaft was continued to the 1600-ft. level, where, after cutting a large station about a month ago, lateral work commenced, with the result that work is now being carried on at four different faces below the lower contact. When it became known that high-grade ore had been opened in the lower workings of the Beaver, greater enthusiasm prevailed in local mining circles than has been shown in several years. The proving of the existence of silver 1600 ft. below the surface is believed to mark another era in the history of mining at Cobalt. Mining men with property near the Beaver are especially pleased, and there is much talk of renewed activity on a number of hitherto doubtful properties; in fact, deep mining will now be the slogan. The Temiskaming mine, which adjoins the Beaver, is being deepened to the lower contact, where it is proposed to connect its workings with a cross-cut from the Beaver, and thus establish good ventilation. This shaft of the Temiskaming is already down over 1500 ft., and before the end of February the workings of these two mines will be connected.

PORCUPINE, ONTARIO

PROGRESS AT THIS IMPORTANT GOLDFIELD. ALSO LARDER LAKE.

The Hollinger Consolidated is being developed to a depth of 1250 ft., and the large orebodies continue as persistent as ever. Furthermore, there is no sign of diminishing gold-content at depth. At present 1300 men are employed in extensive operations. Early in July the management expects to have the new part of the mill in operation, thereby raising the capacity from 1800 to 3800 tons daily. The many veins in the Hollinger are usually from 3 to 12 ft. wide, averaging around $10 per ton. To extract sufficient ore for the mill from these comparatively narrow veins is a problem. To secure sufficient labor is another problem, also the shortage of cyanide. The Hollinger is only one of the large gold mines situated in the small Porcupine goldfield.——The Dome mines will be treating 2000 tons of ore daily by the middle of summer. This, together with the five other mills with an aggregate capacity of twelve hundred tons daily, and the several other plants that are to be erected, within the next year or so, is expected to bring the production of gold from the Porcupine area up to at least $25,000,000 annually, over one-quarter of the United States total in a year. Eight years ago there was one prospector's cabin on the shores of Porcupine lake, where today the district boasts of four thriving towns.

There is probably more activity in the Larder Lake gold area than for 10 years past. The Goldfields company has taken the lead and is now developing on the 300-ft. level. A power-plant at Little Windego, which is owned by the Goldfields, from which the property gets current for its machinery, is being overhauled and enlarged. The Goldfields controls a large area of the choicest of the Larder Lake mineral belt, and development will be watched with interest. The rock formations of the district are remarkably similar to those over an area of at least 400 square miles. Whereas the T. & N. O. railway passes in front of the Boston Creek and Kirkland Lake fields, Larder Lake section is over 20 miles from rail, this tending to impede progress. It is thought that Larder Lake will be entered by the T. & N. O. within two or three years, if the development of some of the properties is successful. The region abounds in game and fish.

GOLDFIELD, NEVADA

A RUN AROUND THE ACTIVE MINES.

It is reported that the Goldfield Consolidated is preparing for resumption of work at the Grizzly Bear mine, idle for a year. It is rumored here that the important strike made at a depth of 1750 ft. by the Atlanta company is largely in Grizzly Bear ground. The Atlanta holds a lease on the mine below the 1500-ft. level, and has been doing some work in this area. Minor troubles continue to delay operation of the Consolidated's flotation plant, but it is expected by the management that the first 500-ton unit will go into commission in two or three weeks. The Atlanta company has arranged for the treatment of 100 tons of ore daily at the flotation plant of Goldfield Con., and has commenced shipments from the vein lately intersected on the 1750-ft. level to custom plants. The pay ore is over 5 ft. wide, and has been opened for a length of 100 ft. It is said to average $50 per ton in gold, silver, and copper, including a 10 to 18-in. streak in the hanging wall that shows specimen ore.

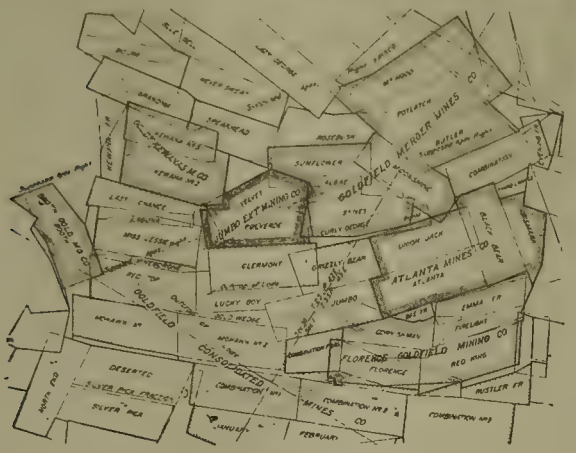
The Red Hill Florence Co. has started extensive work under the management of H. D. McMahon. Repairs to the main shaft are under way and foundations are laid for a 50-hp. electric hoist, compressor, and other machinery. It is estimated 90,000 ft. of timber will be required for the shaft to the 800-ft. level. From this level cross-cuts will be driven to find the main Florence vein. The company is a merger of the Florence American, Florence Extension, and Red Hill companies, and was organized on the assessable basis.

Great Bend has entered the list of shippers, dispatching 10 tons per day of $30 to $40 ore. This is coming from the 210-G raise above the 300-ft. level. The drift from this level is entering similar ore, and prospects for development of a good quantity are encouraging. From the 160-ft. level a drift is advancing on low-grade ore.

The Cracker Jack company has purchased the Rabbitt Trail, General Washington No. 1, Gold Queen Extension, and Triangular Fraction claims, a total area of 50 acres. The discovery that the Cracker Jack vein dips flatly into the purchased area hastened its acquisition. A new pump has been installed on the 520-ft. level of the Cracker Jack shaft, and from this point

drifts will be extended to open the Cracker Jack and Rabbit Trail veins.

Goldfield Merger is preparing to drive in hopes of intersecting the vein exposed in the Atlanta. The manager of the Silver Pick, reports that the orebody encountered 195 ft. west of the 1050-ft. level shows a width of 16 ft., with the foot-wall



PROPERTY MAP OF GOLDFIELD, NEVADA.

still to be reached. It is thought that some of this ore can be extracted profitably. Development is going ahead steadily at the Grandma, Kewanas, Sandstorm-Kendall, and several other mines. The receiver, Harry B. Clapp, has placed the indebtedness of the Florence Goldfield Mining Co. at $344,318 to date. A detailed report will probably be filed soon.

BAKER, OREGON

MINING IN NORTH-EAST AND SOUTH-WEST OREGON.

The Buck Gulch Mining Co. has been working all winter with a few men driving in gravel and developing preparatory to stoping and sluicing operations. The mine is three miles from Sumpter, Baker county. Two years ago the present company acquired the mine from Sumpter people and drove an adit 1000 ft., opening the cemented gravel of an old river-channel, which had been prospected previously from the surface. It is understood that recent sampling of the gravel has given encouraging returns, and that there is a large quantity of it. Shareholders are mainly California people. Martin Costello is manager. The mine is fully equipped.

Twohy Bros. are working their copper mine near Grants Pass. It is proving to be one of the best mines in the State, and it is expected that the owners will do a large amount of work this year.

The Conner Creek mine near Huntington, in Baker county, where a rich discovery was made in December, previously mentioned in the PRESS, is operating its 10-stamp mill on good ore. The high-grade ore has been nearly extracted, but there is a good vein of milling ore that is developing well. The rich ore exists in pockets; some large ones were taken out years ago.

The Laclede mine near Baker, in Baker county, has been reopened under the management of John Gyllenberg of Baker. The mine was operated years ago, but has been shut-down for several years. It is understood that a large amount of money is to be spent should preliminary work warrant it.

Several mining deals of importance are pending in the Bohemia district out from Cottage Grove, waiting for the heavy snow to melt. One engineer from Spokane recently made an examination in spite of the weather. Several old mines are expected to be re-opened this spring as soon as road conditions permit; the Champion is one. This mine has been worked with varying success by different companies. Some rich ore has been extracted, and it is considered a property of promise.

Spring placer mining in southern Oregon is under way. A number of the placers can only work during spring while water is plentiful, although some of the larger mines with their long ditches are more fortunate.

JACKSON, CALIFORNIA

HARDENBURG MINE.—TREASURE AND ORIGINAL AMADOR MILLS.

Unwatering and repairing the shaft at the Hardenberg mine on the Mokelumne river is finished, and actual mining operations have been started. Two levels, at 850 and 1000 ft., were opened by former owners and ore was opened at both points, a 6-ft. shoot, 430 ft. long, of good value, on the 1000-ft. level. The heavy hanging wall and black-slate gouge foot-wall made former operations expensive, but it is thought that the ore can be extracted profitably. The vertical shaft has three compartments, and has been sunk 1100 ft.; this depth will be increased to 1500 ft., at which point it should intersect the vein. The mill is equipped with 20 stamps and eight Frue vanners, and both hoist and mill are electrically driven. The mine is being re-opened by the W. J. Loring company.

The new mill at the Treasure mine, north of Amador City, is doing good work. The recovery is stated as 90%. This plant began crushing on July 5th last, and with the exception of time lost during the strike has been steadily and profitably employed on ore extracted during sinking.

The Hardinge mills, which superseded the stamps at the Original Amador mine, are said to be satisfactory. The mill was re-modeled during last fall, a ball-mill and a pebble-mill being installed. The recovery made is slightly over 90%, and the new equipment treats 100 tons per day more than was possible with the 20 stamps formerly used.

Average progress in sinking the Central Eureka shaft to 3400 ft. is 15 ft. per week. Driving is in progress on the 6-ft. vein cut by the 2500-ft. cross-cut early this month, and the gold-content continues good. Mill ore is also being extracted from the 2825-ft. stopes. Thirty stamps are crushing.

TORONTO, ONTARIO

COBALT, PORCUPINE, AND KIRKLAND LAKE.

The finding of rich silver ore on the lower contact between diabase and Keewatin formations, at a depth of 1600 ft. in the Beaver Consolidated, has aroused much interest at Cobalt. It means much for the future of that part of the field.——The new 75-ton flotation plant at the National had a few trial runs, but it closed temporarily on account of machinery troubles. ——During 1916 the Crown Reserve made a profit of only $2973 out of $191,822 gross.

At Porcupine, labor shortage has interfered with work at the Hollinger.——The vein at 200 ft. in the Schumacher is 22 ft. wide, worth $6 per ton.——The Newray has let a contract for 10,000 ft. of diamond-drilling.——Some high-grade ore has been opened at 300 ft. in the Davidson.

Kirkland Lake will show more activity when the power-line from Cobalt is completed.——The Teck-Hughes 100-ton mill awaits current for motors.——The Lake Shore is to erect a 100-ton mill in March.——The Kirkland Lake company has completed plans for a large plant.

Seven feet from the vein mentioned in the Beaver, and parallel with it, is another of similar formation and value. The rock occurring between the two veins is intersected with calcite stringers running horizontally from one vein to the other, carrying heavy leaf silver.

North-east of Cobalt the Dickson Creek company is sinking on a 10-in. vein in conglomerate. The shaft will be deepened to the diabase contact.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

ANCHORAGE. This division of the Federal railroad employs 1962 men. Fair progress is reported from the Matanuska and Turnagain branches.

JUNEAU. During January the Alaska Gastineau company treated 173,300 tons of $1.24 ore, with 81.95% recovery. In December the total was 196,495 tons of $1.22 ore.

In the appeal suit of the Alaska Juneau *v.* the Ebner company concerning water-rights on Gold creek, the Circuit Court of Appeals upheld the previous decision, so the Ebner gets 3200 miner's inches of water for operation in Last Chance.

ARIZONA

Bulletin 49 of the Bureau of Mines at Tucson deals briefly with ores of aluminum, platinum, tin, cadmium, nickel, cobalt, arsenic, and bismuth. Occurrences of these minerals are practically unknown in Arizona.

CHLORIDE. Utah people, headed by A. M. McDonald, have purchased the Payroll mine on lease and bond. It has been opened to 400 ft., and shows good zinc ore at depth.

OATMAN. Shipments of bullion have been made from the Tom Reed and United Eastern mines from January operations. The latter sent four bars weighing 350 lb. to the Mint at San Francisco, the first consignment from this mine. About half of the January run was on ore, the balance of the time being consumed in adjusting the new mill to its requirements. The normal capacity is 200 tons per day. Ore treated in January averaged $21 per ton.

The United Eastern shipped February 20 gold bullion weighing 405 lb. avoirdupois, the clean-up for the first two weeks of February.

Four feet of low-grade ore, which shows colors in panning, has been cut on the 400-ft. level of the Adams mine. One piece taken out shows free gold. The cross-cut is 12 ft. into the vein without finding the foot-wall. The property is in the Black Range section of Oatman.

Sinking has been resumed at the Nellie, which was shut-down for three weeks by an accident to the hoist. The shaft is in the vein at 370 ft., and will be continued to a depth of 500 ft., where the vein will again be developed. Some good ore was encountered on the hanging wall on the 350-ft. level, but gold-content was erratic.

A station has been cut at 600 ft. in the Big Jim mine, and as soon as a sump has been cut out cross-cutting will be commenced. The vein should be encountered within 90 feet.

RAY. The Ray Consolidated Copper Co. reports as follows for the last quarter of 1916:

Development opened 19,965 ft. of ground. Ore reserves were re-calculated during the year, giving an additional 20,000,000 tons of 1.5% ore, making the total 91,000,000 tons averaging 2.05% copper. To date over 13,000,000 tons has been extracted. Mining during the period cost 84.16c. per ton, including 5.34c. for coarse crushing. The mill treated 871,700 tons of 1.649% ore, with 75.32% recovery. The last three periods of 1916 showed increased tonnages and production. The copper output, including 940,950 lb. from ore shipped direct to the smelter at Hayden, was 21,651,956 lb. The mill results are the best recorded, due to improvements. The power-plant additions are complete. Dividends totaled $789,302. The net cost of production was 9.769c. per pound.

TUCSON. In driving an adit to open the andesite-rhyolite contact, known to carry high gold-content, the Arizona-Tonopah Mining & Milling Co. has cut an immense body of low-grade copper ore, from 20 to 100 ft. wide, carrying chalcocite, bornite, and chalcopyrite. The company is making preparations to sink a three-compartment incline shaft to a depth of 1000 ft. Modern air-drills and semi-Diesel gas-engines are installed at the property, and work is progressing much faster than heretofore. A. J. Harshberger is superintendent. Additional property has just been bought at an approximate cost of $85,000.

ARKANSAS

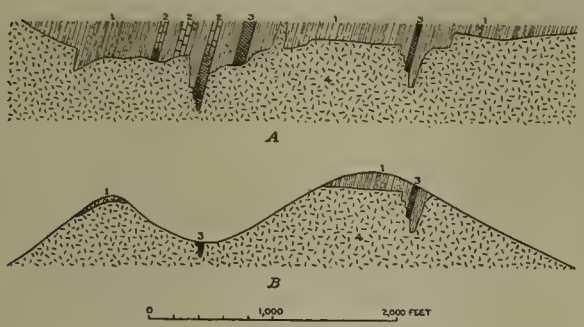
On account of cold weather and bad roads in January zinc production of northern Arkansas was low, only 1148 tons.

CALIFORNIA

AUBURN. The Valley View mine, 8 miles from Lincoln in Placer county, was sold by the W. B. Hellings estate of San Francisco to J. C. Winters and others of New York for $100,000. Machinery worth $75,000 has been ordered. E. P. Stephenson of the Sacramento Ore Testing & Machinery Co. sampled the mine. The ore contains gold and copper.

BISHOP. The valuable tungsten deposits near Bishop, the principal town of Owens valley, are described in a report (Bulletin 640-L, by Adolph Knopf) just issued by the U. S. Geological Survey. These deposits are mined in Deep canyon, which traverses an isolated group of hills at the base of the Sierra Nevada. Similar groups of hills farther south in Owens valley are known by distinctive names, such as the Alabama hills, and the name Tungsten hills has been suggested for the group in which the principal tungsten deposits have been found. The hills reach an altitude of 6000 ft., or about 1500 ft. above the floor of Owens valley, but they are dwarfed into insignificance by the range behind them, which towers to 13,000 ft. Tungsten ore was first found in place in August, 1913, on the Jackrabbit claim, near the present centre of mining activity. Three partners, who were mining placer gold in Deep canyon, found that the concentrate they obtained was difficult to clean because the gold was invariably accompanied by a heavy white mineral. This troublesome material proved to be scheelite, and when its identity and value became known search for it was soon begun. It is reported that after all the quartz float in the area adjoining Deep canyon had been broken open in vain during a search that covered 18 months, the scheelite was finally found in its rock matrix by J. G. Powning, who while out hunting, recognized the long-sought mineral in an outcrop of garnet rock on which he had just shot a rabbit, an incident to which the discovery claim owes its name. At this place the scheelite is embedded in the blackish garnet rock in particles, somewhat larger than those commonly found in the orebodies of the district, but it is neither so prominent nor so obviously recognizable that it would have been found had it not been the special object of search. The discovery that the scheelite occurs in the garnet rock, however, made prospecting for tungsten simple. The blackish garnet masses on the bare hills contrast notably with the prevailing gray and reddish granite and are therefore easily recognized. They were soon staked and were then tested for tungsten, and in this way ore was found at many places. As a rule this scheelite is so inconspicuous that the largest orebody, although it outcrops prominently, was at first unfavorably reported on by competent engineers, because

they were unable to ascertain its trend and consequently its width and length. The deposits, although found in 1913, remained practically unknown until the spring of 1916, when their exploitation was energetically begun. By midsummer two mills, having a total daily capacity of 400 tons, had been completed and were in active operation. The ore consists of scheelite, garnet, epidote, quartz, and other minerals. The country-rock is prevailingly granitic, but it includes isolated masses of limestone which became mineralized soon after the magma that now forms the granitic rock was intruded into them. The metallic vapors then given off from this magma altered the limestones to masses of garnet-carrying subordinate scheelite, and these altered rocks are the tungsten deposits now under exploitation. The orebodies that are now mined are from 20 to 60 ft. wide and from 150 to 260 ft. long. The ore carries from 1.5 to 2% of tungsten trioxide (WO_3). The area in which scheelite-bearing deposits have been found forms a belt 20 miles long, but the prospecting now going on



Diagrammatic sections showing the relation of the metamorphic-sedimentary rocks and orebodies to the intrusive-granitic rocks of the Tungsten hills, California. A, at the time of intrusion; B, at the present time, when erosion has removed most of the rock that formerly covered the granites and has evolved the existing topography. 1, metamorphic-sedimentary rocks; 2, limestone; 3, tungsten orebodies; 4, granitic rock.

will doubtless extend the dimensions of the field. These deposits, like those discovered in recent years in Humboldt county, Nevada, are of the contact-metamorphic class, a well-known source of copper and iron, but until lately not widely recognized as a possible source of tungsten.

REDDING. The Gardella company, operating on Clear creek, is soon to construct another dredge. Four boats are expected to be working by the end of 1917.

IDAHO

KELLOGG. During 1916 the Caledonia Mining Co. mined 17,464 tons of ore assaying 29.81 lb. lead, 74.28 oz. silver, and 2.2 lb. copper. The gross value was $1,769,670. Costs were $3.42 per ton. The profit was $1,154,763. After paying $78,150 per month in dividends, cash in banks amounts to $309,395, included in a surplus of $441,982.

MISSOURI

JOPLIN. Prices for ores improved last week, the average being $88 per ton for 60% blende, $45 for 40% calamine, and $104 for 80% lead. The total output was worth $660,628.

Turbine troubles at the Empire District company's steam plant have curtailed work in the district.

MONTANA

BUTTE. Ore reserves of the Bannack gold mine are estimated at 130,700 tons of ore averaging $7.34 per ton, also 106,000 tons of $6 ore. Estimated profits in these quantities are $1,160,000. Current debts total $114,144, for which bonds of $125,000 are to be issued. The new mill will resume in the spring.

HELENA. A report has been made by C. E. Fryberger on the property of the Scratch Gravel Gold Mining Co., which is two miles north-west of Helena. The vein consists of quartz in andesite. Reserves are estimated at 49,711 tons averaging $24.50 per ton. So far only the high-grade ore has been extracted and sent to the East Helena smelter, which returned $50 per ton gross on 3694 tons. Probable ore on the 500 and 600-ft. levels is valued at $1,939,311 net. The company is erecting a mill of 200-ton capacity, in which custom ore will be treated also.

(Special Correspondence.)—According to present indications mining will be active in all of the old districts near Lewistown in central Montana. The success obtained last summer in re-opening old mines in the Judith mountains has attracted capital to the Maiden and Cone Butte districts. Eastern people intend to examine carefully the Spotted Horse, Maginness, and Cumberland mines at Maiden, with a view to purchasing and consolidating them. The Sutter claims on West Armell creek are also under consideration. The metal-content at Maiden is nearly all gold, while in the Sutter group it is mostly copper.

The Mammoth claims near Giltedge has been bonded to Butte people for $35,000. This property is equipped with a 50-ton cyanide mill, which produced considerable gold from ore worth $6 per ton several years ago. It has been closed since on account of disagreement among the owners. Development will be started early in the spring, and $15,000 will be spent in repairing the property and searching for new orebodies. If results are satisfactory the mill will resume.

A large body of gold ore has been found in the Big Chicago property in the Cone Butte district of the Judiths, according to R. J. Mellor, who has been prospecting there for several months. An adit has been driven 200 ft. on the shoot, which has been prospected for 3000 ft. The value is variable, but averages $2 per ton. Work is active on several lead-silver properties in this district. Badger and Lachovich recently shipped a carload of high-grade copper and lead ore to the East Helena smelter, with satisfactory returns.

The ownership of the townsite of Maiden in the Judith mountains is in doubt. It is the oldest town of any size in central Montana, and has 150 inhabitants. W. M. Hausel has filed on a half section of land that covers the town. It is claimed that the place grew on unpatented placer locations, and that the plat of the town was never recorded. One patented mining claim of 20 acres is embraced in the homestead, and without doubt will stand. It is said that no assessment work was done on the placer claims sold for town lots and that the townsite is therefore Government land. The owners have paid taxes on their lots for many years. Fire destroyed much of Maiden several years ago, but there are about a dozen occupied business blocks and many residences on the land whose ownership is in doubt.

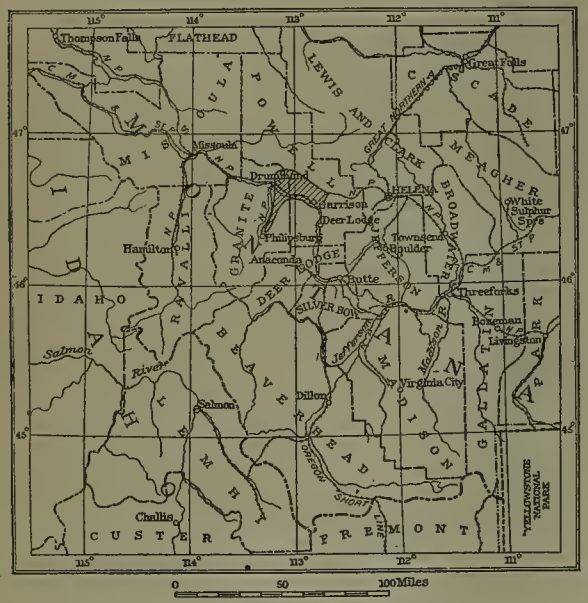
In the North Moccasin mountains the Barnes-King properties are producing at the rate of $15,000 per month, employing 60 men. Lessees at the Kendall mine have ceased to mill the ore on account of weather conditions, but are extracting ore and doing development with favorable results. According to A. S. Wright, a well-known mining promoter of Lewistown, plans are being made to re-open the Gold Links mine at Kendall. Work will soon be started, and if it proves successful a 200-ton cyanide plant will be erected. The Gold Links adjoins the Barnes-King, and is opened by a 535-ft. shaft. It is said that the shaft was in ore when the mine was closed some years ago.

Lewistown, February 15.

Phosphate deposits of the Garrison and Philipsburg fields are described by J. T. Pardee in Bulletin 640-K of the U. S. Geological Survey. The economic results of the investigation may be summarized as follows:

Workable deposits of high-grade rock phosphate (containing 60% or more tri-calcium phosphate) occur in both the Gar-

rison and Philipsburg fields. That in the Garrison field lies 6 to 10 miles north of the town of Garrison and is easily accessible, and the portion considered as available to mining contains by estimate 97,000,000 long tons, an amount about twice as great as the total production of the United States to date. About one-third of the amount lies above the natural drainage-levels, and much of this can be readily extracted by means of adits driven along the phosphate bed. In the Philips-



PART OF MONTANA, SHOWING PHOSPHATE FIELDS.

burg field too little work has been done to justify a tonnage estimate, but the deposits are believed to be extensive, and are known to be in two places at least of workable size and readily available to mining.

NEVADA

AURORA. During 1916 the Aurora Consolidated yielded gold worth $621,252. The expenditure was $65,817 above this.

BATTLE MOUNTAIN. The Antimony & Silver Mines Co. of Salt Lake City is erecting a mill on its property near this place. The grinding equipment has been ordered from the Denver Quartz Mill & Crusher Co.

BELMONT. The Highbridge shaft of the Monitor Belmont company has been opened to the 200-ft. level. The vein which is over 15 ft. wide on the 75-ft. level shows no diminution in size. A five-drill compressor and enlarged hoist are being installed. The mill is closed pending alterations.

ELY. During the last quarter of 1916 the Nevada Consolidated Copper Co. treated 979,329 tons of ore averaging 1.63% copper. This was a decrease of 41,217 tons. Open-cuts supplied 79% of the ore, the remainder coming from the Ruth mine. The output of metal was 22,898,228 lb. Cost of production was 9.32c. per lb., an increase of 0.65c. From the net earnings of $4,526,027, dividends were paid totaling $2,999,186. Assets, including metals at smelter, in transit, and refinery are valued at $9,265,013.

On account of additions to the Nevada Consolidated mill and smelter the Nevada Northern Railway, now hauling 12,000 tons daily, is preparing to carry 18,000 tons.

GOLDFIELD. At a depth of 73 ft. below the 1017-ft. level the Jumbo Extension core-drill has cut the alaskite-shale contact. There is no value in the rock so far.

THOMPSON. The Mason Valley company's smelter, idle for over two years, is again in blast.

VIRGINIA CITY. About 600,000 tons of $4 tailing from the old Comstock mines is to be treated by a 150-ton plant being built for the Dayton Placer Recovery Co. G. T. Hansen is president of the company at Dayton.

NEW MEXICO

(Special Correspondence.)—The Socorro mill marketed 10,500 oz. of gold and 616,520 oz. of silver during 1916. Excluding shipments made direct to smelter, the Mogollon district produced 17,681 oz. of gold and 987,870 oz. silver in 1916. This is 50% of the silver and 26% of the gold produced in New Mexico last year. For the past 15 years or over, Mogollon has produced without fail at the rate of $1,000,000 per year. With the prospects of cheap hydro-electric power, and that lower-grade ore can also be profitably treated, past production will undoubtedly be materially increased.

Mogollon, January 30.

SANTA RITA. During the last quarter of 1916 the Chino Copper Co.'s profit was $3,428,976, of which $2,174,950 was paid in dividends. The cost was 8.89c. per lb. of copper. There was treated at Hurley 790,000 tons of 1.78% ore, yielding, with crude ore smelted direct, 20,602,946 lb. The year's output was 75,551,322 lb.

OREGON

CORNUCOPIA. There is a possibility of a new electric power-line being erected to the Cornucopia mining district this year to supply current during the low water season. The Eastern Oregon Light & Power Co., with offices at Boise, Idaho, has been approached recently by R. M. Betts of the Cornucopia Mines Co. The nearest power-plant is 26 miles from Cornucopia, at Copperfield, Oregon, on the Snake river, and is known as the Ox Bow. During the past year an effort was made by the Electric company to construct a line; but nothing was done, as the company wished to stop the local power-plants, if its line was put in, and as the water is ample for power purposes during eight months of the year and considerably cheaper than the power from the company mentioned, this could not be considered. The mining companies, however, would be glad to have the line so as to operate full capacity during the winter months. The present winter has been harder than usual on the local power, due to little snow and very cold weather.

TEXAS

AUSTIN. The graphite deposits of Burnet and Llano counties have been examined by W. B. Phillips, former director of the Bureau of Economic Geology and Technology. The deposits are considered to be extensive, and of high quality. The mineral is of the crystalline variety. The ore should yield 8 to 10% flake graphite.

EL PASO. During 1916 ores and metals passing through this place from Mexico were as under:

	Tons	Value
Copper ore	5,908	$86,266
Copper matte	683	12,021
Gold ore	.....	36,314
Gold bullion	.....	80,441
Lead ore	46,434	284,081
Silver ore	.....	738,262
Silver bullion	.....	566,730
Zinc ore	38,286	761,323

UTAH

AMERICAN FORK. Gas issuing from the limestone in the Miller Hill adit has suspended work at the face, in spite of an exhaust fan working at capacity.

BINGHAM. During the last quarter of 1916 the Utah Copper Co. made a profit of $8,503,926 from milling operations, and a

total of $10,651,608 from all sources. Dividends amounted to $5,685,715. Overburden removed was 1,287,503 cu. yd. The mills treated 2,846,600 tons of 1.4742% ore, recovering 60.44%. This quantity was 557,700 tons less than in the September period. The smelter yielded 196,752,631 lb. in 1916, of which 50,723,245 lb. was made in the period under review. Extremely bad weather curtailed operations in December.

The Ohio Copper Co. is treating 2000 tons of 0.9% ore daily. The recovery is 45%, but flotation is being tried. Present profits are $30,000 per month. The mine contains millions of tons of 0.8% ore.

EUREKA. During 1916 the Chief Consolidated Mining Co.'s development covered 25,844 ft. Results were good, especially at 1800 ft. Ore shipments totaled 83,606 tons, lead ore being 68,961 tons. The metal-content of all ores was 8331 oz. gold, 1,739,004 oz. silver, 18,356,937 lb. lead, 1795 lb. copper, and 790,525 lb. zinc, all a large increase when compared with the 1915 yield. The income from all sources was $1,601,903. Dividends totaled $176,481. The balance is $477,295.

SALT LAKE CITY. The Utah Power & Light Co. reports as follows for 1916: revenue, $4,342,089; profit, $2,257,638; interest, $1,013,300; and surplus, $1,244,338. The profit was an increase of $528,914 over that of 1915.

WASHINGTON

CHEWELAH. During 1916 the United Copper Mining Co.'s profit was $123,706. Gross receipts were $374,131. Dividends are to be continued at the rate of $10,000 monthly, equal to 1%. The shaft below the 1000-ft. level is being sunk to 1500 feet.

NORTHPORT. During 1916 the Electric Point Mining Co. made a profit of $48,753, plus $45,000 due on 61 cars of silver-lead ore at the smelter. An initial dividend of 1% has been paid. In five months of production the output was 1194 tons of sulphide and 7764 tons of carbonate ore shipped. These are high-grade products.

CANADA

BRITISH COLUMBIA

The following table shows the great value of the Trail smelter to this province, the tonnage of ores received being for 1916:

	Tons
East Kootenay	99,531
West Kootenay:	
Ainsworth division	13,171
Slocan division	16,461
Nelson division	4,792
Trail Creek (Rossland) division	293,409
Arrow Lake division	8
Trout Lake division	120
Revelstoke division	415
Boundary	15,339
Yale:	
Nicola division	553
Ashcroft division	41
Kamloops division	4,531
Vancouver island	46
Omineca division	766
Alberta	52
Yukon Territory	38
Ontario	444
United States (Washington)	36,971
Total	486,688

This was in increase of 45,063 tons over the 1915 total, due mainly to the East Kootenay district. Rossland fell off over 40,000 tons, while Boundary gained 15,000 tons.

In the February Bulletin of the Canadian Mining Institute, F. A. Thompson of the State college at Pullman, Washington, gave notes on local treatment of some west Kootenay silver ores. He considers that amalgamation is not necessary, concentration will become necessary with the deeper ores, fine-grinding and strong cyanide solution will treat ore from the Ainsworth district. Concentration and cyanidation yield a high recovery. Erection of plants is not advised unless large quantities of ore are available.

ONTARIO

The report of the Temiskaming Mining Co. for 1916 is to hand, and the general manager, F. L. Culver, includes the following:

The main shaft is within 100 ft. of the underlying contact between the diabase and keewatin formations. When reached, lateral work will be started to prove the existence of ore. The vein system opened late in 1914 still yields large quantities of rich ore. More or less favorable results continue from the old vein system, and there is a large tonnage yet to be extracted. Development in 1916 totaled 5243 ft. On the dumps is 150,000 tons of 4-oz. tailing, and as flotation tests have been successful a plant is to be erected for its treatment. The mill treated 32,897 tons of ore in 309 days, yielding 333,431 oz of silver. Including metal from high-grade ore the total output was 1,263,848 oz. The cost was 26.4c. per oz. Dividends (3) totaled $225,000.

The McKinley-Darragh company is erecting a ball-mill to take the place of its 50 stamps. The 100-ton flotation plant is working well.

KOREA

The Seoul Mining Co. reports the following results for the month of January: total recovery of gold, $118,950. Milling operations stopped for several days during the month because of theft of copper wire from the power-line. A great improvement in prospects is reported, also the same for the Tul Mi Chung mine.

MEXICO

In *The Yale Review* for January 1917, John Barrett gives a review and forecast of Mexico. This was reprinted in the January 'Bulletin' of the Pan-American Union. The position of Mexico gives it a strategic advantage in international trade, especially as it has 5500 miles of coast-line. Geographically and climatically the republic is intended to become the ultimate home of a highly civilized, prosperous, and peace-loving population. Under conditions of peace Mexico can produce practically everything in minerals, metals, timber, and agricultural products which are necessary for the maintenance and prosperity of a great people and nation. The country only has about one-fifth of the railway mileage it actually needs. The Indian and peon classes are not so illiterate as supposed; and the feeling against Americans is not so bitter as frequently published. The necessities that would evolve permanent stability, peace, and prosperity are: (1) Establishment of conditions which will have the confidence and support of Mexicans and foreigners; (2) an enlargement and ramification of the public educational system; (3) improved methods of agriculture; (4) improvement of labor conditions in both industrial and agricultural industries; (5) establishment of new industries that would utilize domestic products, employ local and foreign capital, and so increase the population and progress of the interior; (6) encourage immigration of the right kind from the United States and Europe; (7) investment of foreign capital to help the Government and to develop the country; (8) construction of railroads, highways, telegraph, and telephone lines; (9) mutual acquaintance between Mexicans and Americans to be fostered by travel; (10) study of Spanish and all things connected with Mexico to be undertaken in United States schools; and (11) co-operation between Mexico and the United States to promote the cause of practical Pan-Americanism and to strengthen the solidarity of the American Republics.

PHILIPPINE ISLANDS

MANILA. The Division of Mines, Bureau of Science, has issued its bulletin on the mineral resources of the Territory for 1915. The total value was ₱4,867,586, of which gold was ₱2,633,528; silver, ₱15,665; and non-metals the remainder. In 1914 the total was ₱4,613,391. The gold output during 9 years shows a good increase, as follows from 1907: ₱187,647, ₱434,500, ₱495,194, ₱308,860, ₱379,906, ₱1,140,424, ₱1,736,724. ₱2,349,267, and ₱2,633,528. Both dredging and lode mines are responsible for the gain. Progress during 1916 is discussed by V. E. Lednicky, who also writes on Philippine mining possibilities, the Acupan Mining Co.'s operations at Baguio, and the

iron industry. Dredging is reviewed by F. B. Ingersoll, salt by T. Dar Juan, and coal by F. R. Yeasiano. A new map, from which the one accompanying these notes is reproduced, is included with the report. In the archipelago of the Territory are 1600 islands, many of which contain minerals and many islands are practically unexplored. The Bureau of Science is mapping available deposits, but as geologists are lacking the work is slow. Intelligent prospecting should be encouraged, there being less than 100 real prospectors in the islands. The rank tropical vegetation is a handicap to exploration.

The Philippine government has issued a 25-page press bulletin on industrial possibilities in the Territory. The materials covered are paper-pulp, copra, gums, tanning products, leather, sugar, spirits, oils, rubber, soils, water supply, iron ore, coal, lime, clay, and fauna and flora.

Dwight T. Smith, principal of the VIRGINIA CITY SCHOOL OF MINES reports that splendid progress was made in 1916, when there was an average of 9.4 members per month, against 7.2 in 1915. Over 1000 samples were tested for prospectors.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

JAMES M. PLATT has gone to Peru.

J. R. FINLAY was at Miami, Arizona, last week.

N. M. MUIR has returned from Jarbidge, Nevada.

MORTON WEBBER was at Clifton, Arizona, recently.

W. PELLEW-HARVEY has returned to London from Australia.

FREDERICK W. GAY has gone to New York for about six weeks.

WALTER NEAL has returned to the Amparo mine in Jalisco, Mexico.

F. R. WEEKES is in California, with headquarters at Darwin, Inyo county.

HOWLAND BANCROFT has returned from South America to his office at Denver.

D. C. JACKLING is making a visit of inspection to the Ray and Chino Mines.

WARREN EARL GREENOUGH of Spokane is taking a holiday at Coronado, California.

FRANK LAWRANCE has left San Antonio, Lower California, for a visit to San Francisco.

HIROSHI ABEY, of the Mitsubishi Company, is making a tour of American mining districts.

R. L. FEAGLES, mechanical engineer with the Deister Machine Co., is in San Francisco.

ALGERNON DEL MAR has gone to Siskiyou county to take the management of the Dewey mine.

JAMES NELSON has returned to the Amparo mine, for McKeever Bros., in Jalisco, Mexico.

COURTENAY DE KALB, who has been visiting the Globe district, is expected in San Francisco.

H. W. DARLING has been appointed manager of the Dome Lake mine, at Porcupine, Ontario.

FREDERICK HELLMAN was in San Francisco this week, and is now on his way back to New York.

ETIENNE A. RITTER, of Colorado Springs, passed through San Francisco on his way from Oatman to Colorado Springs.

GEORGE W. GOETHALS announces that he has opened an office as consulting engineer at 43 Exchange Place, New York.

CECIL GORE-LANGTON, recently at Owen's Lake, has obtained an appointment on the staff of the Inspiration Consolidated, at Miami, Arizona.

E. J. SCHRADER has fully recovered from an operation performed at Lane Hospital, San Francisco, in December, and is back at Rockland, Nevada.

M. W. VON BERNEWITZ has left the MINING & SCIENTIFIC PRESS, and is now available for a vacancy at any metallurgical works, or in a consulting capacity.

J. O. GREENAN, recently with the exploration department of the Goldfield Consolidated, has been appointed superintendent of the Olympic mine, at Mina, Nevada.

E. P. MATHEWSON has been awarded the gold medal of the Mining and Metallurgical Society of America in recognition of his achievements in non-ferrous metallurgy.

W. F. M. GOSS, for many years associated with the schools of engineering of Purdue University, and since 1907, Dean of the College of Engineering of the University of Illinois, has resigned that office, effective March 1, 1917, to assume the presidency of the Railway Car Manufacturers' Association.

W. N. THAYER recently returned to Cincinnati, Ohio, after making an examination of oil-land in south-western Kentucky. The good results made by the Estill County field last year have stimulated prospecting, chiefly of the wild-cat type. A few operators are working under the direction of geologists.

THE METAL MARKET

METAL PRICES

San Francisco, February 20.

Antimony, cents per pound	24
Electrolytic copper, cents per pound	36
Pig lead, cents per pound	8.75— 9.75
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$140
Spelter, cents per pound	12
Tin, cents per pound	47.50
Zinc-dust, cents per pound	18

ORE PRICES

San Francisco, February 20.

Antimony, 50% metal, per unit	$1.50
Chrome, 40% and over, f.o.b. cars California, per ton	18.00—20.00
Magnesite, crude, per ton	8.00—10.00
Manganese, 50% (under 35% metal not desired)	16.00
Tungsten, 60% WO_3 per unit	17.50—18.00

New York, February 14.

Tungsten is unchanged at $17 per unit, molybdenite at $1.80 per pound for 90% concentrate, and antimony ore at $1.85 per unit.

EASTERN METAL MARKET

(By wire from New York.)

February 20.—Copper is strong but quiet. Lead, if nearby, commands a premium. Spelter is quiet and spot metal is scarce.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Feb. 14	34.50	Jan. 9	28.20
" 15	35.00	" 16	28.33
" 16	35.50	" 23	29.34
" 17	35.50	" 30	31.91
" 18 Sunday		Feb. 6	33.00
" 19	35.75	" 13	33.90
" 20	36.00	" 20	35.37

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	....	Aug.	17.27	27.03	....
Mch.	14.80	26.65	....	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Feb. 14	78.37	Jan. 9	75.28
" 15	78.37	" 16	74.66
" 16	78.62	" 23	75.87
" 17	78.62	" 30	75.87
" 18 Sunday		Feb. 6	76.79
" 19	78.37	" 13	77.62
" 20	78.12	" 20	78.41

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	48.85	56.76	75.41	July	47.52	63.06	....
Feb.	48.45	56.74	....	Aug.	47.11	66.07	....
Mch.	50.61	57.89	....	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

Unremitting demand from abroad, together with the additional scarcity of supply created by unsettled shipping conditions which have seriously interfered with shipments out of New York, are factors to which are attributed the steadily rising silver market of the last few days.

The cessation of sales from China and the paucity of supplies from America have imparted steadiness to the market. At one time the entry of Indian Bazaar buyers to cover bear sales caused an apprehension that the price might be forced up considerably, but when 37¼d. was reached on January 22 competition eased off.

The issue of a sterling loan in India may attract some rupees into the Treasury. It will be interesting to see whether sales of gold will have any effect upon the Indian currency figures.

On December 8 the following enactment was made in Hongkong: "Rule 37. No person shall export without special permission of the Superintendent of Imports and Exports or attempt to export, or procure for the purpose of exportation, any silver dollars or silver bullion."

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Feb. 14	9.00	Jan. 9	7.50
" 15	9.25	" 16	7.50
" 16	9.25	" 23	7.72
" 17	9.50	" 30	8.02
" 18 Sunday		Feb. 6	8.41
" 19	10.25	" 13	8.60
" 20	10.25	" 20	9.58

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	....	Aug.	4.67	6.28	....
Mch.	4.04	7.26	....	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Feb. 14	10.75	Jan. 9	9.66
" 15	10.50	" 16	9.37
" 16	10.50	" 23	10.00
" 17	10.50	" 30	10.41
" 18 Sunday		Feb. 6	10.06
" 19	10.50	" 13	10.52
" 20	10.50	" 20	10.54

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	....	Aug.	14.17	9.03	....
Mch.	8.40	18.40	....	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date.			
Jan. 23	80.00	Feb. 6	90.00
" 30	85.00	" 13	140.00
		" 20	140.00

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	....	Aug.	93.75	74.50	....
Mch.	78.00	219.00	....	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	....	Aug.	34.37	38.88	....
Mch.	48.76	50.50	....	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Tin is firm at 50 cents.

ALUMINUM

The quotation for No. 1 virgin aluminum, 98 to 99% pure, is unchanged at 57 to 59c. per pound. Trade is hampered by the difficulty of making deliveries.

PLATINUM

Price of platinum, New York, is $105 per ounce for soft metal and $111 for hard.

Eastern Metal Market

New York, February 14.

Uncertainty as to the outcome of this Nation's attitude toward Germany, the general difficulty of making shipments and getting deliveries by rail, and the handicap imposed by severe cold weather are influences which have made the metal markets quiet in the past week. It is as difficult to obtain raw materials as to make shipments of finished products—a condition which disturbs every industry.

The copper market is almost at a standstill except for occasional sales of small lots of spot at fancy prices. Copper is extremely strong, and there is every indication of its remaining so.

Zinc is firm. The curtailment of its production probably will be felt later.

Of all the metals, lead seems to be the hardest hit because of delays in transportation. Spot lots are selling for 9c. and over, St. Louis. The A. S. & R. Co. quotes 8.50c., New York.

Tin is arriving freely, and the recent scare has been discounted to such an extent that prices have dropped 2c.

Antimony has been sold at 30c. per lb. in the week. Spot is scarce. Aluminum is steady.

The breaking down of the railroads, for that is what it amounts to, with a consequent failure of deliveries against contracts is creating a spot market for all sorts of products at premium prices. Pig iron is quoted at eastern Pennsylvania furnaces at $31 to $33 per ton for foundry grades. At Buffalo $35 is asked for No. 2X. Steel-making grades are strong, but do not show such an active tendency to advance. As a result of the cold and insufficient transportation, about 25% of the producing capacity of the Central West in pig iron and steel is idle. Of the Steel Corporation's furnaces about 30 are out of blast. The situation with regard to Germany does not seem to have lessened the demand for iron and steel products; on the contrary, with many mills, additional specifications have been received, mostly from consumers who fear that the United States government may commandeer a good part of the capacity of the mills. The railroads continue to place equipment orders at a lively rate.

COPPER

The market is strong, but there is very little doing. Buying is confined almost entirely to small lots of re-sale metal that are taken only because of the urgent needs of a few consumers whose operations are limited. It is estimated that all the business of the past week does not exceed more than 1000 to 1500 tons. Under these circumstances, sellers find it easy to obtain premiums from the buyers. Late last week, some spot was available at 34.50c., cash, but to-day that is about the price for March. It is reported that small lots of spot brought 36c. The producers have made it clear repeatedly that they have no first-half metal to sell, and now it appears that some of them are not anxious to sell for July delivery. They prefer to wait and see where political events will lead, and, so far as possible, to keep themselves in a position to care for the Government's requirements should these become abnormal. The nominal quotation for second-quarter copper is between 32.50 and 33.50c. The export situation is a rather puzzling one. It is estimated that copper should be going abroad at the rate of about 90,000,000 lb. per month, yet exports are far from that level. In January, for instance, the exports were only a little over 57,000,000 lb. and so far this month (Feb. 1 to 14) they total only 26,250,560. One plausible explanation of the showing is that large quantities are being shipped to American manufacturers of munitions to be applied against foreign orders. Amid all the conjecture, one thing is certain, and that is that the metal is as strong as it was prior to the recent peace talk which smashed the market. The London quotation for spot electrolytic yesterday was £147, or £1 higher than a week ago.

ZINC

All interests, on both the buying and consuming sides, show a tendency to await developments; consequently the market has been quiet during the past week, but quotations are firm at slightly higher levels than prevailed a week ago. Prompt prime Western was quoted yesterday at 10.75c., New York, and 10.50c., St. Louis. March is around 10.50c., New York, and at St. Louis, about 10.25c., with second quarter near 9.75c., St. Louis. Brass mill special is 1 to 1¼c. over these prices. Severe weather in the West continues to restrict production, an influence which sooner or later will be felt in the market. The London quotation for spot, as compared with a week ago, was unchanged yesterday at £47. The exports, Feb. 1 to 14, total 4524 tons. Sheet zinc is unchanged at 21c. per pound f.o.b. mill, 8% off for cash.

LEAD

Uncertain and long-delayed railroad deliveries from the West continue to hold spot lead at high levels, considerably over 9c. having been paid. An occasional carload gets through, but the arrivals are not sufficient greatly to relieve the situation, and the law of supply and demand rules. On February 8, a lot of 500 tons of February lead was taken by a consumer at 9c., St. Louis, and even early March shipment at this level. No relief is in sight. The A. S. & R. Co. advanced its quotations $10 per ton, February 9, making its price per pound 8.50c., New York and 8.42½c., St. Louis. Although it is reported that the leading interest has made sales to some of its large and regular customers at the new prices, the general understanding is that the company's quotations are more generally used in monthly settlements on an average basis. The exports, February 1 to 14, total only 330 tons. The London quotation for spot yesterday was unchanged at £30 10s., as compared with a week previous.

TIN

The week has been quiet. Fear over the possible loss of cargoes through the activity of submarines has been discounted to such an extent that prices have declined about 2c. in the past week. Spot Straits was quoted yesterday at 53c., New York, whereas a week ago it was 55c. An interesting phase of the situation has been the wide difference between Straits and Banca—2½ to 3c. Arrivals in the past two or three days have been larger than were expected, especially of Banca. Arrivals of the month total 1525 tons, and there is afloat 3498 tons. Large quantities are likely to turn up unexpectedly because of the meagre information available relating to sailings from the other side.

ANTIMONY

Reports have been published of extremely large buying for munitions purposes, some of it being credited to providing for possible future requirements of the United States government, but the trade is skeptical about such buying, and construes the reports as an effort to boost the market. More or less of the supposed desired result has been attained, inasmuch as spot Chinese and Japanese antimony is quoted at 28 to 30c., duty paid. The trade, however, credits the strong position of the metal rather to the short supply than to any other cause. There is no question but that shipments from the Pacific Coast have been greatly delayed, while another influence making for a higher market is faulty cable service with the Far East, which interferes with business.

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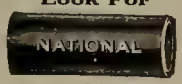

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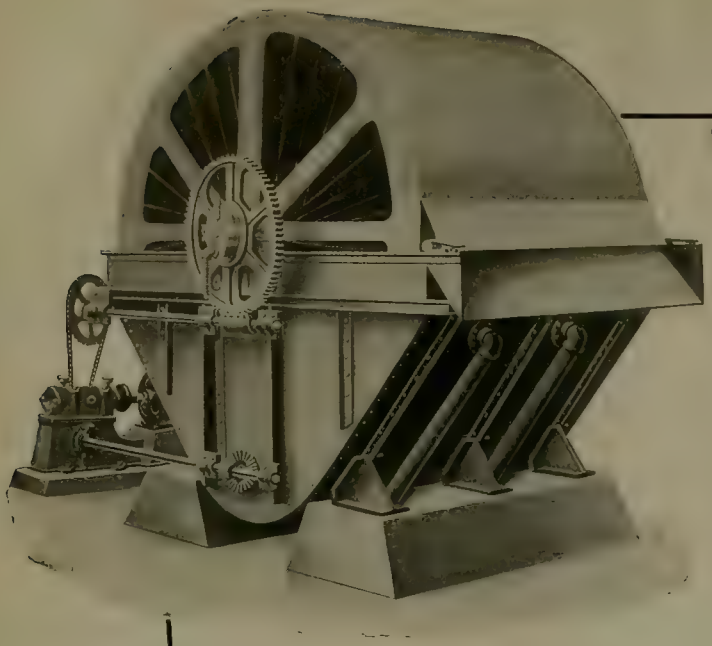

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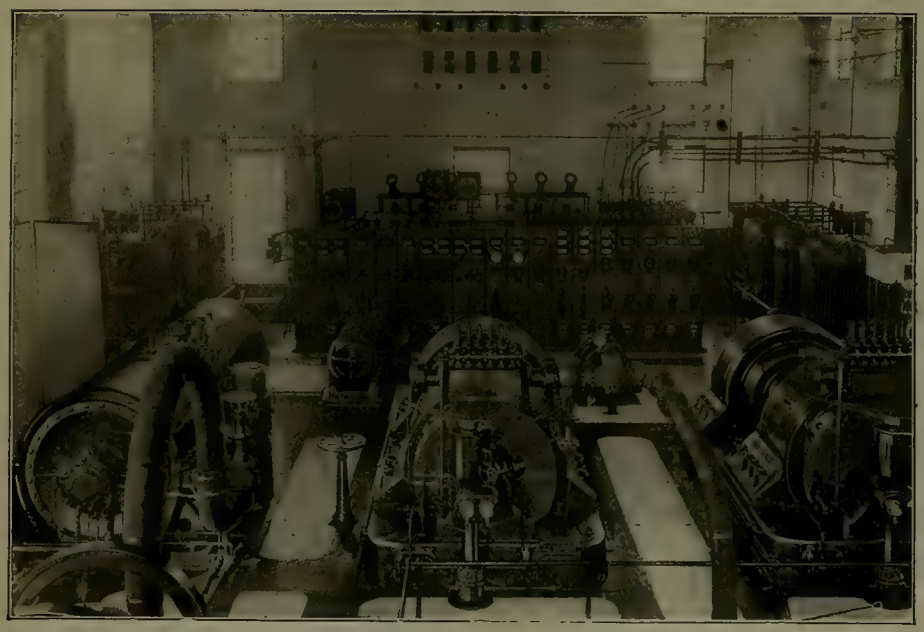

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EDITORIAL

T. A. RICKARD, Editor

WE publish a most interesting letter from our Mexican correspondent.

COURTENAY DE KALB has become Associate Editor of this paper.

WEST AFRICA produced less gold in 1916 than in 1915 or 1914. The total was 389,068 ounces, worth £1,615,306 or $7,834,234. The decrease, as compared with 1915, is $442,159. The Ashanti Gold Fields company continues to be the chief producer of gold in this region.

TO see ourselves as others see us is a stretch of philosophic imagination that has been commended by cynics, and by others better natured. It is one way to learn. We take pleasure in publishing the notes of a metallurgical engineer from foreign parts that recently visited the principal reduction plants in Arizona, Colorado, and Montana. His review was not intended for publication and is therefore all the more interesting.

REFERRING to the Freeman process, invented by C. A. Freeman, we are able to state that a 3 to 10% solution of soda-ash, or carbonate of soda, is used for floating preferentially the galena in Broken Hill ore without the aid of oil. Subsequent use of oil serves to separate the zinc-blende from the tailing. Any copper in the ore is floated in the first, or leady, froth, which is cleaned in a potassium bi-chromate solution, so as to recover both the copper and the lead in the form of a marketable concentrate.

A BILL is pending before the Nevada legislature for an official inspector of shipments of ore to smelters and other custom reduction works in the State. Besides the chief inspector, the bill provides for a staff of five assistants. Obviously the creation of this new office represents an effort to protect the small shipper and to insure a square deal for all parties concerned in the sale, purchase, and treatment of ores. Whether it will accomplish much in harmonizing the constantly recurring differences between ore-shippers and the custom-reduction works is an open question. "For ways that are dark and tricks that are vain" the smelters and sampling-works people in Nevada "are" not "peculiar."

ONE man's food is another man's poison. While millions have been beggared by the War, it has been the good fortune of a few to make tremendous gains. E. I. du Pont de Nemours & Co., the famous powder business, earned $82,107,693 net in 1916, and $57,840,758 in 1915, as compared with $5,603,153 in 1914. This has been done by the expenditure of $60,000,000 in plant construction, but the new capital has been already amortized. In 1916 the company earned 133.31% on its $58,854,200 common stock, after paying $3,648,222 as interest on its debentures. On December 31 last the cash balance was $82,325,103 and in 1916 the gross sales amounted to $318,845,685. Even after War is over, this company will be a big industrial factor, for it will utilize its big equipment for other useful purposes.

PATENTS granted in the United States during the week ended February 13 made a total of 930; of this number probably not 5% will ever be commercially successful. The report of the Commissioner of Patents, Mr. Thomas Ewing, covering the work of the Patent-Office during 1916, has been issued. Out of 71,033 applications for patent of all kinds, 45,927 were granted. These figures exclude designs, trade-marks, and the like. The Department received $2,343,541 from all sources, and spent $2,115,368; therefore the Patent-Office was operated at a profit of $228,173 and the average cost per patent was $46. The scientific library was enriched by only $2306 worth of books. The defense of suits cost $567. The average time that successful applications had to wait for patent was 21 months. The building is over-crowded, and conditions are growing worse. The latest patent is No. 12,162,516.

LABOR-UNIONS are useful, and even necessary, for the protection of employees in many industries, but the stupidity of some of their performances passes belief. Suddenly, not many days ago, the 24 crane-men and 58 electrical-workers at the Anaconda smelter laid down their tools and walked out. Was it because they had an insufferable grievance against the company? Not at all. Their hours and wages were most satisfactory. No, they had a quarrel with the mill and smelter-men's union. It appears that the smelter-men's union and the electrical-workers' union alike claimed 'jurisdiction' over the crane-men. Some of the latter did not pay their dues to the smelter-men's union, which then called upon the company to dismiss them, according to agreement with the union. But the electrical-workers' union insisted that the crane-men should be re-instated and when the company could not please them also, they walked out. A pretty kettle of fish! The Anaconda company has asked the American Federation of Labor, to which all the contending parties belong, to settle the trouble. Unless better sense is shown, and the unions respect their own

agreements, the company will be warranted in adopting the open-shop system. That would be a step backward from the employees' standpoint, and possibly from the employers' also.

SIMPLEEFIDE SPELLUN was the subject of a recent meeting at New York, in which representatives of several technical societies participated. Among others the A. I. M. E. was represented. Hence our interest in the matter. At the close of the meeting sundry spellings were adopted and others rejected. Many of them are already in vogue, others never will be—thank Heaven! Several rules on hyphenation were passed, but all that need be said about them is that they disclose ignorance of the function of the hyphen. Why discuss hyphens with people that write 'to-day'? The idea of settling such matters by the vote of the editors of the technical societies and of publishing houses is based on a fallacy, namely, the notion that the publications of either one or the other are in the hands of literary men keenly interested in the niceties of spelling or style. The opinion of an experienced writer, like Dr. Raymond, is worth that of a roomful of non-literary technical men. The present secretary of the Institute is a most efficient executive but unless we are much mistaken he does not care about the minutiæ of writing, nor has he the time to attend to them; certainly the papers published by the Institute owe more to their authors and to providence than to the editing they receive, if we may judge by the wide variation in the amount of revision that we find necessary before they appear in our pages. The meeting to which we refer agreed to ascertain the usage adopted by a number of organizations, some of which have a style that like Topsy "just growed up" anyhow. They would do well to consult one of the most conscientious and intelligent of technical critics, the editor of the U. S. Geological Survey.

AMONG the commendable regulations of the New York Stock Exchange is the one compelling disclosure of the business of a company when it seeks to list a new issue of shares. To this regulation we owe some interesting information. For example, the Cerro de Pasco Copper Corporation, a Hearst-Haggin enterprise in Peru, has been persistently secretive concerning its operations since it started in 1902. Now, on asking for 666,666 new shares to be listed, the corporation has had to make a detailed statement. This shows that it controls the Cerro de Pasco Mining, the Morococha Mining, and the Cerro de Pasco Railway companies, and from them it obtained the income of $3,420,000 earned in 1916. The ore in reserve in the parent mine is estimated at 3,000,000 tons containing 253,452,000 pounds of copper and 21,745,000 ounces of silver, that is, the ore averages about 4.2% copper and 7 oz. silver per ton. Of the total smelter production, 40% comes from Cerro de Pasco and 60% from Morococha. Besides the main supply of copper-sulphide ore, estimated to last for 10 years, there is a large quantity of oxidized low-grade silver ore—8 to 30 oz. per ton—that is not included in the assured reserves. The company owns two large coal mines. From 1908 to 1915 inclusive the smelter returns, including those from custom ore, amounted to $64,300,000, of which $50,000,000 represented copper, $11,000,000 silver, and $3,300,000 the gold content. In those eight years the smelter treated 2,358,000 tons of ore and produced 340,000,000 pounds of copper, an average of 7.2%, and 19,802,000 ounces of silver, an average of 8.4 ounces per ton, besides 154,200 ounces of gold. The expansion of the Cerro de Pasco output has synchronized with the War, the production of 1914, '15, and '16 having been 43, 60, and 70 million pounds of copper respectively.

DISCUSSION this week begins with a timely letter from Mr. Howard D. Smith on the sampling of the immense low-grade orebodies now being exploited near Juneau, Alaska. Mr. Smith is particularly well qualified by his experience to attack the problem. Our comment is deferred until next week. Mr. H. M. Wolfin, of the U. S. Bureau of Mines, gives information concerning the law regulating the action of employers and employees in the matter of safety underground. Mr. R. T. Hancock writes from a distant mining district, in Nigeria, to suggest a rapid method for determining the tungsten in a mixed concentrate. We thank him for it. Our recent editorial on the supply of cyanide has drawn a letter from the American manufacturer of that chemical, Roessler & Hasslacher. It will be good news to many of our readers to learn that an ample supply is promised by July and that no attempt is being made by the manufacturer to raise the price—this unpleasant result of the existing scarcity being attributable to enterprising middlemen. An anonymous reader objects to our recent dicta on short-selling and contributes a story that has point. The gambler in the story made a bet on the stock-market and called it a mining venture. Mining has to carry the blame for many such 'flyers.' They are nearer related to Monte Carlo than to Montana. Mr. E. Coppée Thurston, an engineer recently a helper on the Belgian Relief Commission, endorses the appeal for funds and urges us all to support the good work. Mr. Storms makes an interesting observation on the association of magnetite with copper-sulphide ore. Mr. John A. Roos tells us how to get rid of a headache caused by 'powder-smoke.' Professor Weeks comes back to the discussion of misfires and makes an excellent suggestion regarding primers. Our recent article on milling practice at the Nickel Plate mine has elicited some useful supplementary remarks from the superintendent of the mill, Mr. Roscoe Wheeler. He gives additional data concerning the agitator that he uses in the cyanide plant. Mr. Henry Mentle, manager for the Snake River Mines Company, gives some practical hints on stamp-milling, based largely on his experience at Cornucopia, Oregon, whose heavily pyritic ores have run the gamut of metallurgical treatment, from simple stamp-milling, through roasting, to cyanidation, besides several side-steps. Mr. Reuben Yost—with the accent on the Reuben—tells of using machines for unsuitable purposes, and the results.

Finally, an 'old-timer' records his protest against the suggestion to substitute a money-payment in lieu of assessment work on locations.

A Mexican Constitution

In Mexico there is a brand-new constitution. Liberal extracts from it appear in a letter from our Mexican correspondent. To some unfortunate investors, whose property happens to lie within those portions of Mexico dominated by the long-whiskered First Chief, this document must needs be taken seriously. It profoundly affects the *status quo,* considering that it has become the acknowledged policy of our Government to ignore the treaty-rights of our citizens. The regulation set forth in the first sub-section of Carranza's astounding State paper declaring forfeit the property of any foreigner who may invoke the support of his own government for the protection of his rights under a special concession from Mexico, is a step forward in arrogance, constituting a virtual disregard of the commercial conventions between this country and the Mexican Republic. Had our relations with Carranza's government been conducted in the customary manner through a duly accredited embassy, this attempted invasion of guaranteed international privilege would have been made immediately the subject of serious protest to the Mexican executive. Failure to obtain proper assurances for the observance of our treaty-rights would have led to a rupture of diplomatic relations, and to a state of mutual suspicion and reprisal possessed at least of the merits of sincerity and comprehensibility.

At the present time we are technically at peace with Mexico, we technically possess treaty-rights in Mexico, our nationals technically enjoy privileges of commerce and property-tenure in Mexico, yet collectively and individually the American people is solemnly admonished by our State Department to keep out of that country. Is the tardy sending of a diplomatic representative from Washington to Querétaro, or to whatever safe retreat the First Chief may select, intended as a means for bringing the pitiful farce to a conclusion? We venture this as a last hope in the ultimate good sense of our Administration. In the usual course of diplomacy justification for the recall of Ambassador Fletcher will quickly enough be found. That will be the end of the whiskered pomposity who has hurled more insults at this Government than it has received from all other sources throughout its entire previous history. Unsupported by the Administration at Washington, Carranza's tottering government must speedily fall. Not even his bill of anarchistic license, termed a 'constitution,' can save him. It does not express the will of the Mexican people. It expresses ostensibly the principles of Magonism, as proclaimed in the reeking pages of *La Resurreccion,* while craftily it subserves the interests of *cientificos* like Carranza and his intimates, who espoused the cause of the so-called *Constitucionalistas* as a clever ruse for avoiding the confiscation of their own estates. Carranza has deceived a few of his countrymen, but not many. His direct followers represent a herd, contented while he throws corn into their mangers, but ready to transfer their allegiance as soon as a new leader demonstrates that he can feed them equally well. The great mass of the Mexican people, quiet, law-abiding by nature, seeking an independent existence as petty rural proprietors, is watching for the joker in the new constitution. It must promptly appear to anyone who reads the extracts printed in our Mexican correspondence. In great detail it is there stated how the dispossessed heirs to communal estates may come into their own again. In the days of the grafting *caciques* the laws made it singularly easy to ignore both justice and equity in acquiring titles, by due process of law, to estates that all the world knew belonged in reality to the lowly workers born upon the soil. Señor Carranza could furnish an explanation of the process in its minute and harrowing details, as exemplified in the absorption of certain rich principalities in Coahuila that he has not yet relinquished to the poor. The new constitution purports to undo all this mischief of the *cientificos,* which is the basis of the revolution. The civil strife in Mexico may have been set going by competitive oil-engines, but a real grievance must underlie a popular movement of this sort when it is sustained by a characteristically litigious nation. The grievance was the robbery of the lands from the common people. Agrarian reform has been the watchword of the revolution. Let anyone give honest dependable agrarian reform, and the revolution will cease. The malcontents and trouble-makers could then in very truth be denominated 'bandits.' At the present time they are entitled to be called revolutionists. There is something to revolt against in the face of this Carrancista 'constitution.' It provides no scheme of reform; it gives no guarantees; the reforms in the end, as our correspondent shows, are dependent upon 'executive decree.' Though they may be defined and prescribed in this farcical document, and amplified by State and Federal legislation, the initiative rests with the executive, and there is no appeal to the courts. The judiciary is empowered merely to fix the amount of compensation to the former owner of record, after the executive has set in motion the machinery of expropriation for the benefit of the poor. Will Señor Carranza set this machinery in motion against his own great estates? Does it appear that Señor Carranza intends to let the poor obtain relief when he so cleverly arranges to hold the reins of justice in his own arbitrary hands?

We repeat that this entire ridiculous pretense at 'reform' is not to be taken seriously except in so far as it affects a few unfortunates who are still trying to do business under Carranza's administration. The Querétaro 'constitution' itself is unconstitutional. The Constitution of 1857 prescribed the way in which it might be amended, and Carranza has paid no heed to that detail. Carranza protested against the alleged violation of the Constitution of 1857 by Huerta; he rode into power as the head of the Constitutionalist party, defending the sacred instrument which he now coolly sets aside,

and none of whose mandates he has respected. Why has he not chosen to first legalize his own position under the document he championed, and then accomplish reforms by constitutional amendment or by statute? The fact is that, in following the straight and narrow path, the prize of the presidency might elude him. Either during the period of a presidency *ad interim*, or as subsequent elective president, the executive control must pass out of his clutches. He has no safe stool-pigeon in sight. To retain his power he must dodge the Constitution of the Republic; hence he places himself today in an unconstitutional position. His government is not the government of that Mexico with which we have treaty relations; he actually administers only a fraction of the country and cannot by any possibility be considered either *de jure*, or *de facto*, ruler of Mexico. The document which his minions wrote at his dictation at Querétaro is likely to be the cause of his undoing. Instead of justifying his defiance of the fundamental law of Mexico, it is certain to disgust every man who hopes for reform at home, and to bring diplomatic disaster through its infraction of the rights of foreigners.

A Technical Conversazione

The group of gentlemen in New York that call themselves the Mining and Metallurgical Society of America have the pleasure of meeting at monthly intervals, and when they do so they say much that is interesting. For instance, the discussion recorded in the latest bulletin of the Society was devoted to the effect of the existing abnormal conditions on the cost of mining and smelting operations. Mr. Sidney Jennings emphasized the foreign origin of run-of-mine labor. "The mining of ore in the United States is done almost entirely by foreigners." At the mines with which he was connected, 27 different nationalities were represented. The War did not call many of them away—no such proportion, we presume, as went from the Canadian mines to the trenches in Europe. Those that have been working steadily at current wages are accumulating a fortune, and when peace is restored many of them will return to their native land. Mr. Judd Stewart quoted statistics showing that in normal times 30 to 40% of all immigrants return to their home-country. When the War is over, he said, an exodus of labor to Europe will follow, and the shortage will be acute. Mr. M. B. Spaulding, the chairman of the meeting, mentioned the fact that the passenger-space on the big German boats interned in New York harbor had all been engaged by those awaiting the chance to re-cross the Atlantic. As regards the increased cost of labor, Mr. Jennings stated that wages now were 60% higher than three years ago. Mr. Walter Douglas gave the rise as 48% for all-white labor at Bisbee and 70% for mixed labor at Morenci, as compared with 1914. Mr. J. Parke Channing estimated the increase at 55% as compared with the early part of 1914. As labor represents about two-thirds of the total cost of mining, it is apparent that the principal economic factor has changed greatly, and yet without disastrous effect. Most of the engineers present agreed as to this, although Mr. H. H. Alexander, referring to lead refining, asserted that, in his experience, common labor shows a decrease in efficiency ranging from 25 to 30%. This did not apply, he added, "to the steady labor, furnace-men, helpers, and that class, who have been long on the job. They are doing as much work as ever." Likewise Mr. F. R. Pyne thought that the efficiency of labor had declined "20 to 30 and 40%." Mr. Channing, however, stated that efficiency at Miami had not been affected by higher wages, "so that the tons per man per day remain just about the same as they were in the early part of 1914." Mr. L. D. Ricketts said, while in San Francisco, that although the average pay at Inspiration was $5.40, the cost of mining was only 61 cents per ton, each man breaking 16 to 18½ tons per shift. On the whole, it is fair to conclude that skilled labor has been stimulated to better effort by reason of higher pay. Mr. H. H. Stout testified that when an increase of wages was demanded and obtained by a strike the efficiency declined as much as 28% for a few months, but when an increase was conceded before it was demanded, so that it became "more or less of a surprise," the efficiency of the men rose about 12%. Mr. George C. Stone complained of the scarcity of skilled furnace-men in zinc smelting, owing largely to the great increase in the number of plants. Mr. W. R. Ingalls stated that the cost of labor for smelting zinc ore had doubled, while material of every kind was two to three times more expensive. He estimated the total cost of smelting at $16.53, as against $8.25 before the War, exclusive of the cost of natural gas as fuel, which had risen enormously. At Miami the cost of producing copper rose only half a cent per pound in 1916 as compared with 1915, so Mr. Channing stated. All of the refiners complain of the increase in the value of the metallurgic losses owing to the higher price of the metals themselves. A touch of humor, however, is not wanting in the plaintive tone of these speakers, all of whom are connected with, or themselves participating in, large-scale mining and metallurgic operations of a most profitable kind—of a kind that has been highly benefited by the set of conditions on which they were animadverting. It is noteworthy that most of these captains of industry did not fear trouble when wages have to be reduced in consequence of the inevitable market reaction at the end of the War. In this pious expectation they seem to us sanguine. Mr. H. H. Stout suggested that where the sliding scale is in vogue the payment to workmen should be made in two checks, so as to emphasize the meaning of the bonus, as an excess-payment due to temporarily high metal-prices. One other note may be made, namely, that the relatively small increase in cost of production, despite higher wages, is not wholly due to better organization or to improved mechanical devices, but is traceable largely to more expansive mining, stoping of reserves, and general growth of tonnage in order to make the most of a favorable market. The day of reckoning is inevitable. After this orgy of production will come the need for sober development.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Sampling Low-Grade Orebodies

The Editor:

Sir—The question you addressed to Mr. John H. Mackenzie, concerning the sampling of orebodies such as the Alaska Gastineau, brings up a subject that has been obscured in recent years. It has become the custom to ascertain the gold-content of such orebodies by milling considerable tonnages, usually taken from a few places, or, as in the case of the Alaska Gastineau, from only one part of the mine. It is reported that in this case an error arose through the tonnage being under-stated and the recovery consequently over-stated. Plainly the same caution must be taken in accepting mill-returns for their face-value as in case of moil-samples.

Despite your own long experience and valuable book on sampling, you, Sir, have held forth at times on the impossibility of arriving at conclusions of value by sampling certain orebodies. I can hardly believe that such views are seriously held, but rather that they are put forth by you to stimulate controversy and thereby to elicit useful discussion.

Gold is known to be distributed erratically, therefore it is contended that samples should be taken on a milling scale in the case of large low-grade gold deposits. Because of their size, the question of what they represent is sometimes lost sight of. The effort to handle a large tonnage is apt to result in getting mere grab-samples on a grand scale. Many sections properly placed must be cut across the orebodies, as when moiling samples, and, of course, every care must be taken to guard against salting or other sources of error.

Objection is made that the amount of work and expense incidental to thorough sampling is prohibitive on such a property as the Alaska Gastineau. The cash outlay on this mine has been, I understand, in excess of $7,000,000. Two per cent would not be an excessive proportion to spend on essential sampling. With a sum of $140,000 much additional information could have been obtained. The matter of keeping results from different samples separate is much simplified in this case, as the product is wholly in the form of a concentrate, readily cleaned-up instead of coming partly as amalgam on copper plates and partly as other mill-products.

The plant used should be specially arranged. Everything milled should first go through the sampling equipment and an automatic tailing-sampler should be constantly in use.

It goes without saying that only a competent engineer can direct such extensive sampling work. Questions of how much waste will be broken with the ore in stoping are most important. The time to determine this is when sampling is in progress. Check-samples must be taken, especially where doubt exists. Many should also be taken with the moil. Such samples, if properly taken and sufficiently numerous, will give valuable results as to grade and definite information concerning the distribution of the gold. Whether all samples should be taken with the moil must be determined by the particular condition obtaining in the mine. Doubtless promoters will continue to urge that their milling samples are more conclusive than the careful sampling done by competent engineers.

It is not contended that the last word as to grade is always obtained by hand-sampling, but any deviation from the sound view that an essential element in systematic mining is thorough sampling cannot be too strongly refuted.

HOWARD D. SMITH.

San Francisco, February 16.

Contributory Negligence

The Editor:

Sir—In your issue of January 27 I find a letter under the title 'How About Contributory Negligence' signed by 'Mine Operator.' It appears that the writer of this letter is under some misapprehension concerning the state of the law and the exercise of power vested by the law in the Industrial Accident Commission, governing the matter of safety in the conduct of mining operations underground, with particular reference to the penal provisions of the law for the infraction of the provisions of the Workmen's Compensation, Insurance and Safety Act, section 55 of which is as follows:

"Sec. 55. No employee shall remove, displace, damage, destroy, or carry off any safety-device or safeguard furnished and provided for use in any employment or place of employment, or interfere in any way with the use thereof by any other person, or interfere with the use of any method or process adopted for the protection of any employee in such employment, or place of employment, or fail or neglect to do every other thing reasonably necessary to protect the life and safety of such employee."

Section 67 of the same law is as follows:

"Sec. 67. Every employer, employee, or other person who, either individually or acting as an officer, agent, or employee of a corporation or other person, violates any safety provision contained in sections 52, 53, 54, or 55

of this Act, or any part of any such provision, or who shall fail or refuse to comply with any such provision or any part thereof, or who, directly or indirectly, knowingly induces another so to do is guilty of a misdemeanor. In any prosecution under this section it shall be deemed *prima facie* evidence of a violation of any such safety provision, that the accused has failed or refused to comply with any order, rule, regulation, or requirement of the Commission relative thereto and the burden of proof shall thereupon rest upon the accused to show that he has complied with such safety provision."

It will be seen that there is not only a prescription for safety and safe conduct but also a drastic penalty for violation, with a presumptive proof of guilt available if the man charged with the offense has violated any of the thoroughgoing rules laid down for his government in the 'Miscellaneous Rules for Underground Men' set forth in section 16 of the 'Mine Safety Rules' at pp. 25-32. Men working underground are required to read these rules, or have the rules read to them, and agree to be governed by them, and to evidence this the signature of the employee is required.

The Industrial Accident Commission has had the benefit of co-operation on the part of both mine-operators and miners. Such co-operation must be sustained and persistent if the best results are to be obtained. There can be no question that the law and the rules of the Commission afford a working basis to accomplish measurable safety in mining operations.

H. M. Wolflin.
San Francisco, February 5. Chief Mine Inspector.

Determination of Tungstic Oxide

The Editor:

Sir—The article in your issue of July 1, 1916, is of special interest to me, as the method therein described is based on the same principle as one I introduced into this district for the rapid determination of cassiterite or tin metal in samples of alluvial concentrate where the impurity was ilmenite. As now extensively used here it has the advantage of requiring no knowlege of chemistry or mineralogy and can be used by anyone.

In a mixture of two minerals, the percentage of either present, or of a metallic element or molecular group in either, can be expressed in terms of the reciprocal of the specific gravity of the sample, that is, of its 'extensity.' Taking the assays and specific gravities given by your contributor, I find that for tungstic oxide, WO_3, the appropriate formula is:

$$\text{the per cent } WO_3 = -305x + 116$$

It follows from this formula that if 305 grams of the sample are taken and its replacement in cubic centimetres measured, a replacement of 116 cc. indicates pure quartz or zero tungstic oxide, and that every cc. less than 116 which the sample occupies indicates that it contains 1% of tungstic oxide.

The determination is conveniently made by pouring the weighed sample into a burette partly filled with water, and noting the reading at which the water stands before and after the addition of the sample. As 305 grams is an inconveniently large sample to take, the quantity may be cut down to half this, when 58 cc. will be the zero and every half cc. less will mean 1% of tungstic oxide. This quantity is within the compass of a 50 cc. burette on high-grade ores, but for very low ones perhaps the weight should be halved again.

As a practical example, assume the method being used in a mill to control the dressing of the product to a 60% grade. Such a product will replace 58 cc. less 30 cc., or 28 cc. First fill the burette with water to the 20 cc. mark and add the 152.5 gram sample. If this goes 60% tungstic oxide the water will stand at 2 cc. in the burette after the addition. Any variation either way can be read from the 2 cc. as 60% and 2% worse for every cc. more.

I should add that this only applies to wolfram and the allied iron-manganese tungstates. Scheelite needs a different formula.

R. T. Hancock.
Jemaa, Northern Nigeria, December 17, 1916.

The Supply of Cyanide

The Editor:

Sir—Referring to the remarks in your issue of February 3, we beg to say that our cyanide factory was established in 1890, and since the introduction of the cyanide process in this country for gold and silver extraction we have supplied the greater portion of the demand for cyanide required for this purpose in the United States.

With the growth of this country's consumption we gradually increased our production. This production continued to grow until the Dingley tariff bill placed cyanide on the 'free list,' after which time the increased demands for mining, fumigating, and industrial purposes were shared by imported cyanide, coming principally from Germany. This condition continued until the beginning of 1915, when importations from Germany were prohibited by the British order in council. England could not produce more than its own requirements, and thus with several thousand tons of cyanide bought and paid for, held in Germany, we were caught quite unprepared to meet this country's requirements.

When this situation developed we immediately started on the enlargement of our raw-material plant at Niagara Falls, increasing as the supply of machinery and raw material permitted us to increase, the latest addition to the Niagara works having just been completed. With this increased production we would have been enabled to meet all requirements. However, the Canadian government late last year claimed the greater part of the power supplied by the American power-companies located on the Canadian side, from which source the larger part of our power was drawn, and this unfortunate condition has created the present shortage in our supply.

Immediately upon the Canadian government's inter-

ference we started the construction of a factory for raw materials at another point, and expect this new source of supply to be running beginning with July, when we will be in position to take care of all demands made upon us.

It has always been our policy to keep the price of cyanide at a low level. In spite of being confronted with very many obstacles, the only increase in price that we were compelled to enforce has been an equivalent of the advances which we were forced to meet in raw material, power, labor, and every other element that enters into the production and packing of cyanide. With the decreased production of raw material at Niagara Falls this also affects the selling price, and yet today our price stands at 28 to 30 cents per pound for cyanide of sodium, which before the War we held at prices ranging between 19 and 22c. for the running pound.

As stated above, we expect to be prepared to supply every demand made upon us, by July 1st, and so much the better if this date can be anticipated.

ROESSLER & HASSLACHER CHEMICAL CO.

New York, February 8.

Short-Selling

The Editor:

Sir—The editorial under this title in your issue of February 17 'reminds me' of an experience of a friend, but first permit me to say that I do not agree that short-selling is iniquitous, dishonest, or piratical, as suggested in your editorial. To me the whole scheme of speculation in the stock-market is nothing more nor less than a gamble as to what the other fellow will do. Too often—generally—the real value of property represented by the stock dealt in is not considered at all, the principal factor being whether a large demand for stock will cause the shares to advance in price or heavy selling force the price down? The fellow who can guess right most frequently will become a millionaire.

In 1906, when copper was at 26 cents, and copper-mine shares were high, a friend of mine was urged to 'get in.' He was not a devotee of the stock-gambling game, though a successful speculator in other lines. He decided to investigate and proceeded to 'read up' on copper. He found the metal to be, as he expressed it, "abnormally high," and concluded that the high price could not be maintained. "A drop in price of the metal," he argued, meant "a drop in the market-value of shares." His reasoning was correct. He sought a suitable medium for his purpose and found it in Amalgamated Copper. He then patiently waited for the anticipated drop, and he had not long to wait. At the first break in price of copper, Amalgamated slid down from somewhere around $100 per share to about $95. My friend ordered his broker to sell a thousand shares of Amalgamated Copper—shares that he did not own, therefore a 'short' sale. The price of the metal continued to decline and so did Amalgamated. At every five-points drop, as the stock fell, he sold a thousand shares at the market, until he had made short-sales of 6000 shares. Then came another period of 'watchful waiting,' and again the wait was of short duration. He 'covered his shorts' at about $55, and cleaned up over $200,000. Was this dishonest? I think not. He was not in the stock-gambling game—merely an interloper, but surely a good guesser. The really amusing thing about it all was that he afterward referred to the incident as, "my little flyer in mining."

AN ONLOOKER.

San Francisco, February 20.

Belgian Relief

The Editor:

Sir—Thank you for opening your editorial columns to Belgian Relief in your issue of February 17th. This brave and long-suffering little nation needs desperately all that we can give her, if she is to survive, and who among us can bear to contemplate her destruction? The last sentence of your able editorial may deter some from giving by suggesting that the German authorities may seize the supplies now in storage in the C. R. B. warehouses in Belgium. The chance of such an action I believe so remote as to be negligible.

The German authorities have given to the C. R. B. and to the Belgium Comité National a very clear and explicit guarantee not to touch any of the food-stuffs imported by the C. R. B. This guarantee the German authorities have always carefully and faithfully observed and it will continue in force whether the C. R. B. continues preponderantly American or not; and, even if the C. R. B. ceases to exist, I am convinced that the Belgians will get the last pound of food stored in the C. R. B. warehouses.

We have put our shoulders to the task of supporting this heroic little people. Let us not slacken in spirit but rather show our sympathy with them and our appreciation of our own Herbert Hoover by increasing our efforts a hundredfold.

E. COPPÉE THURSTON.

San Francisco, February 18.

Magnetite and Iron Sulphide

The Editor:

Sir—The interesting description in your issue of February 24, of the occurrence of magnetite associated with iron and copper sulphides in the ore of the Granby company's mine at Phoenix, B. C., calls to mind similar occurrences elsewhere. I first observed what I thought to be an unusual association of magnetite and sulphide minerals at a mine near Bayha, in Shasta county, California, and later saw a similar deposit in the Bright Diamond mine, a mile north of Ouray, in the San Juan region of Colorado, and I have seen it since in other places. I am under the impression that this association is more common than is generally supposed. C. R. Van Hise, in his treatise on metamorphism, page 845, says:

"Magnetite and pyrite also are often associated." He thinks the magnetite is formed from pyrite and siderite. This association of primary iron sulphide with iron oxide occurs in both copper and gold deposits.

Berkeley, February 27. W. H. STORMS.

Remedy for Powder Headache

The Editor:

Sir—A year or so ago while working in a drift where powder-gas was present in large quantity, I contracted a headache. Leaving the 'muck-pile,' I sat down and began using an ordinary menthol inhaler, and was gratified to find my headache 'on the run.' Since then I have suggested the use of menthol to several friends, each of whom claimed equally good results. I hope this may benefit others.

Ravalli, Montana, February 14. JOHN A. ROOS.

Misfires

The Editor:

Sir—A discussion is a waste of valuable space unless it imparts useful information or brings forth pertinent opinions and facts from the reader, so I shall try to be brief.

In your issue of February 3, Mr. Brooks states: "The method I prefer in making primers is to punch a diagonal hole in the powder near the end of the cartridge, insert the cap, and bend the fuse across the end of the powder, and insert in the hole, cap-end first." The primer, Mr. Brooks goes on to state is the second stick from the collar of the hole. This procedure, as I understand it, causes the closed end of the detonator to point toward the collar of the hole.

By many tests of different sorts it has been proved that a detonator or cap delivers its hardest blow from the closed end. This end then should point in the direction that the detonation wave is to be propagated. The point of the cap should point into and not out of the drill-hole. I do not say that a charge will misfire if the cap is pointed out, but the effectiveness of the shot will be less than if the detonator is pointed toward the bulk of the charge.

Mr. Brooks is correct in saying: "I can hardly believe Mr. Weeks would suggest bulldozing in the face of a drift." I would suggest bulldozing in very few cases where a block-hole could be drilled. Bulldozing may 'get by' where a study of comparative costs is not made. In a recent conversation, Mr. B. L. Thane, manager of the Alaska Gold Mines Co. stated that he was endeavoring to do away with bulldozing in the chambers above the chutes on account of its high cost. His opinion was that a small pocket-drill would be developed for block-holing under such conditions.

To tamp or not to tamp? The no-tamping system is certainly the path of least resistance, actually and metaphorically. If Mr. Brooks is correct in his contention that tamping is useless, I wish to know it, for I loathe unnecessary work, or, as my friend Professor Lawson would term it, "pernicious activity."

The question is rather a vital one, and its discussion I propose to leave to engineers who can produce first-hand evidence.

Berkeley, February 15. W. S. WEEKS.

Slime-Agitation

The Editor:

Sir—In your article, published in your issue of January 20, on the mill of the Hedley Gold Mining Co. in reference to the propeller slime-agitator, you state you "know the power is crucial." This is quite true in some respects, I should say, but not altogether so. On account of the slime being heavy, the specific gravity of the ore being 3.3, considerable hesitation was caused in adopting an efficient method at the least expense, and the present propeller system appeared best adapted to the requirements of the plant. When least expense is considered, it should not dwindle to one item of power. Extraction, supervision, repairs, supplies, delays—anything that breaks the regularity and decreases the net profits—is an expense, as well as the power consumed. Anyone in charge of a mill realizes what it means to have a plant run with clock-like regularity, and that is what the Devereux propeller has done at Hedley—handled as high as 23 tons of slime per horse-power. I have delayed writing purposely, for I wished to give the latest results. Thus far, after running one year there has been no expense except grease—certainly an achievement that will rank with any machinery used in any department of a cyanide plant. As for the power consumed, I question seriously whether the horse-power consumed by the screw-propeller is greater than any of the standard machines in use when working under the same conditions.

At the Santa Gertrudis mill, at Pachuca, Mexico, according to an article by Hugh Rose, in August 1916, Bulletin A. I. M. E., a Pachuca tank 15 ft. diam. by 45 ft. high, probably holding 200 tons of water, or solution, requires 75 cu. ft. of air at 27 lb. pressure, which means about 11.2 hp. is needed to drive the compressor to furnish that amount of air, including compressor-loss, to agitate the charge of probably about 100 tons of dry slime in this one Pachuca tank. I have not access to the exact figures, but figuring from the dimensions given, and allowing for the usual cone at the base of a Pachuca tank, one can verify my figures as to the water-tonnage contents of the tank—as to tonnage of dry slime, good practice would not permit, usually, more than 100 tons in such a tank, or one horse-power for each 9 tons of slime.

Another example: The milling plant of the Compania de Minas La Blanca y Anexas, also at Pachuca, consists of eight Pachuca tanks 60 ft. high by 15 ft. diam. An average pulp-charge is 150 tons of dry slime in 180 tons of solution. One 150-hp. compressor is running every minute of the day to furnish air enough for agitation purposes for eight of these tanks, thereby putting into

agitation 8 × 180 tons, or a total of 1440 tons, or 9.6 tons of dry slime per horse-power.

At Hedley, with a 10-hp. motor, almost up to load, driving a 5 ft. diam. 4-bladed screw-propeller, revolving 76 r.p.m., in a tank of 34 ft. diam. by 18-ft. stave, including a 23° conical bottom, a charge of 191 tons of dry slime is agitated with 278 tons of solution, or 19.1 tons dry slime per horse-power. This is not the usual practice, but when the mill is crowded and delays have caused

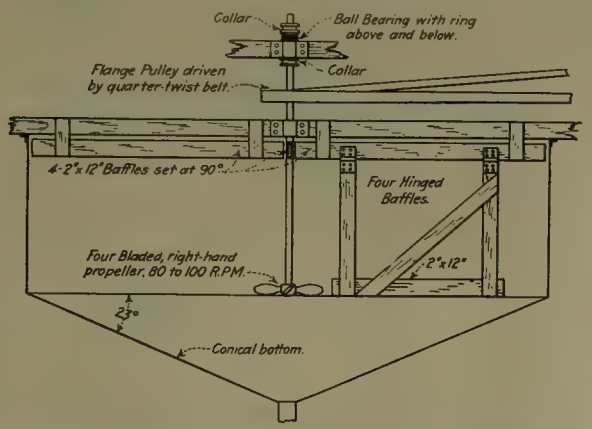

FIG. 1. AGITATION-TANK WITH HINGED BAFFLE-BOARD.

the slime-vats to be loaded more than the proper height, the propeller can be relied upon to do this work without any extra labor or cost involved whatever—it responds to the situation. Where crowding of the charge has buried the propeller *under* three feet of slime it has started without trouble.

Adjusting the revolutions per minute to the size of

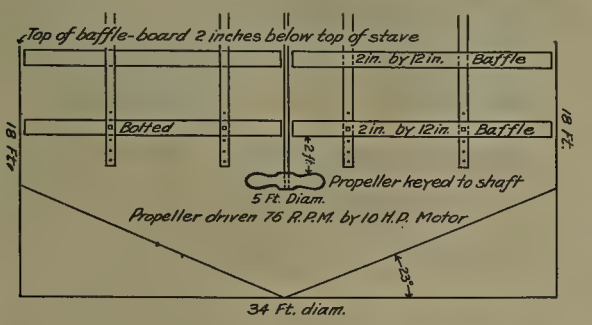

FIG. 2. TANK WITH STATIONARY BAFFLE-BOARD.

the charge usually handled, to the weight of the material, to the style and dimensions of the vat is not a difficult problem, though experience has been a good teacher in my case. As its merits become known, I believe the use of it as an agitator will become more general, as well as the varied uses to which it may be put.

In the arrangement of baffle-boards to prevent surging, changes were made from time to time. First, a hinged baffle-board was tried as Fig. 1. While it worked well, it was not a positive check against carelessness, as it held the baffle in vertical position by a rope from the lower chord of the baffle to a cleat outside the tank. As this rope slipped out of the operator's hand, while fastening, and twisted around the revolving propeller, there was danger of it breaking the shaft. This has now been obviated by a 2 by 12-in. fixed baffle-board across the tank two feet above the propeller as shown in Fig. 2.

Hedley, B. C. February 7. ROSCOE WHEELER.

On Stamp-Milling

The Editor:

Sir—The discussion which has appeared from time to time in your columns relative to the merits of different mills has excited my liveliest interest, as it brings to my mind a controversy I had with an expert mill-man about two years ago at Cornucopia, Oregon. Any mill under adverse conditions cannot do its best work in full measure, and in order that a battery may give a first-hand account of itself the following conditions should obtain:

First: The top of the screen must not incline outward more than 5 to 10° from the perpendicular.

Second: With ores such as we have at Cornucopia, the feed must not be more than one inch; in fact, three-fourths of an inch under ordinary conditions is better still. By 'feed' I mean the ore lying upon the die, when the shoe attached to the lower end of the stamp drops upon it. The less feed given—provided the shoe does not work directly upon the die—the more crushing will be done.

Third: The principal product from our Cornucopia ores being in the form of a concentrate, the discharge should not exceed four inches, and in extreme cases, with such ore as we have in the Queen of the West mine, no discharge need be given. This low discharge of four inches or less causes damage to a screen occasionally because the ore in the battery presses against the screen and bulges it out, but this annoyance and cost of extra screens are more than compensated by the increase in crushing capacity and also extra good work done. The discharge is the distance between the top of the die and the lower edge of the screen, and as the water cannot discharge as rapidly as it flows into the battery, it requires some pressure to do so. Therefore, a four-inch discharge requires a five-inch head.

Fourth: Using a drop of 6 to 8 inches, we can get from 90 to 95 drops per minute. The drop is the distance between the top of the die and the bottom of the shoe at the time when the stamp has reached its greatest height, and the cam is leaving the tappet. Thus a drop of 6 to 8 in. under the foregoing conditions of 4-in. discharge, with one inch of feed on top of the die, would be equal to from 1 to 3 in. of air-drop, and this air-drop is the vital factor of battery efficiency. The stamps in their drop condense and carry the air with them, striking the pulp with a cushioned blow, which disturbs all the pulp in the battery, and it is this disturbance and cushioned blow that creates the splash, lashing the pulp against the screen with such force that all of it that is of the necessary fineness passes through the screen. This air-cushioned blow and splash also wash out and keep the

battery flushed at every drop, thereby preventing sliming of the pulp, which is so much dreaded by mill-men whenever concentrating machines are depended upon to produce desirable results. The experienced battery-man has a keen eye for that splash; if none is present, the battery is not doing its duty. It is also worth while to remark that during the lifetime of the shoe or die, or both, the screens must be kept in proper position; the dies must be kept level and even—all of which plays a very important part in the successful operation of a stamp-mill.

In 1885 the mines of Cornucopia were discovered and in 1887 the late E. P. Torrey erected and operated the first 5-stamp mill in the district. It was supposed to be a most complete reduction works. We used no rock-breaker or ore-feeder, and with the battery and plates, four little Golden Gate concentrators and a section of burlap completed the plant. It was decided to make the first mill-run on low-grade ore packed from the Mayflower, Conundrum, O. R. & N., and other claims. There were seven bosses all equal in authority, and they were all tasting gold. After the mill ran one day, samples were taken—battery-sample $5 per ton, tailing-sample $3.75 per ton; everybody crestfallen. Then Mr. Torrey made a radical change about the battery, and then another day's run gave a battery-sample of $5.10, tailing-sample $1. Everybody jubilant. And while I believed that those stamps and Golden Gates were most wonderful machines to accomplish such reverse and gratifying results, yet, after all, behind that change was E. P. Torrey, indeed a master mill-man. "Oh! so easy." Hocus-pocus, cockalorum! Now you see it; now you don't see it. We all learned our first lesson in stamp-mill practice. And one may realize, after all, it's the man behind the gun that wins the battle.

HENRY MENTLE.

Huntington, Oregon, February 12.

Adaptability of Machinery

The Editor:

Sir—There are machines for almost every possible requirement in mining, and as a general proposition it is safe to say that it is not economy to attempt to adapt a machine intended for one kind of work to the performance of some other kind. I have had a practical demonstration that convinced me thoroughly of the truth of this statement. I was sinking a shaft, and for a hoisting-engine had a single-cylinder end-friction machine, probably intended for use on a dock, or almost anywhere else than at a mine. However, as money was scarce and this hoist, being second-hand, was inexpensive, I bought it. At one side it was equipped with a winch, keyed to a projection of the shaft. I needed a circular saw to cut cord-wood, and to make wedges, but had neither an extra engine nor power to spare. I thought the matter over and then hit on the brilliant idea of removing the winch, substituting fast and loose pulleys, and hooking my hoisting-engine to the saw-mill. This not only looked feasible, but was considered a fine scheme by all of us. To think was to act. The necessary pulleys were bought and placed on the shaft and a complete little saw-mill was set up in front of the engine. When all was in readiness the new arrangement was tried, and it worked fine. We could not have asked more, unless it were a separate and suitable engine to run the saw. For several weeks we used this make-shift contrivance, and then the shaft of the hoisting-engine began to 'wobble,' indicating that the bearings were getting 'out of true.' This condition became worse, and after a few days, it got so bad that the hoisting-engine could not be depended upon, as a hoisting-machine, because it acted in a jerky and unsatisfactory manner. An examination showed that the bearing on one side of the machine was worn much more than that on the opposite side, and that the hoisting-reel with its shaft and bearings would have to go to a machine-shop, which it did. The result was a shut-down of a week and a direct expense of nearly $70, but it was worth more than that to learn by practical demonstration that a hoisting-engine is not designed to run a saw-mill.

REUBEN YOST.

Jamestown, California, February 18.

Mine-Claim Tax v. Annual Labor

The Editor:

Sir—If the mining law is amended so that no actual discovery of "mineral-bearing rock in place" is necessary—a requirement of the present law—and a locator is enabled to hold his claims by annually paying a stipulated amount to the Government, would it not have a deterrent effect on the further development of the mineral resources of the West? As a natural result capitalists would acquire the greater part of the promising ground, particularly in newly-discovered districts, and hold it without development, merely paying the tax required by law, while leaving the actual development of the district to others. This they could afford to do, but it would put an end to the rapid exploitation of new territory that has been such an important feature of Western mining ever since the early days. I hope you will oppose vigorously any such change in the existing mining law.

OLD TIMER.

Manhattan, Nevada, February 10.

GRAPHITE PRODUCTION of Ceylon during 1915 amounted to 21,817 long tons, compared with 14,223 tons in 1914. Early in the past year the industry was quiet, but with the removal of the export embargo, prices advanced quickly and reached $438 per ton for ordinary lump graphite.

SILVER is a better conductor of electricity than copper in the ratio of 1000 to 931, and both metals are better than aluminum for this purpose, though aluminum with twice the sectional area of copper is equally as good as copper as a conductor but is less desirable for other reasons.

PICTURE-WRITING NEAR EGYPTIAN MINES.

AN ANCIENT MINER DRILLING.

Modern Gold Mining in Ancient Egypt

By Ernest H. S. Sampson

The following remarks are supplementary to a short paper that I contributed to the Institution of Mining & Metallurgy in March 1906, entitled 'Gold Mining in Upper Egypt.' At that time considerable interest was evinced in this subject, and several companies had been floated to explore the deserts of Upper Egypt and the Sudan for ancient mines that might prove of value, and to undertake the development of new prospects. Among these companies were the Egyptian Mines Exploration Co. with its subsidiaries, the Central Egypt Exploration Co., the Fatira Exploring Co., and the Eridia Exploring Co. Of these the Central Egypt Exploration Co. was engaged in developing two prospects called respectively Fowakhir and Atallah. The former is situated on the northern Keneh-Kosseir road, a main caravan-route between the Nile and the Red Sea, 400 miles south of Cairo, and the latter is about 15 miles due north of Fowakhir.

Fowakhir was subsequently abandoned as unprofitable. Development work at Atallah, however, disclosed a rich vein of auriferous quartz, or rather a series of parallel veins for there were six in all. This mine was afterward taken over by John Taylor & Sons, and the last account I heard was that they were erecting a reduction plant on the property. The Fatira Exploring Co. investigated the old mines of Fatira and Semna—both considerably north of Atallah. The former proved to be low-grade, and, in view of a heavy influx of water, and lack of facilities at that time for unwatering the workings, it was abandoned.

Semna was, perhaps, the most promising of all the prospects in that district; a large and fairly rich vein being opened along an outcrop of about 1000 ft. As I was in charge of the operations there for two years I am able to give a fairly full account of this particular property, as I propose to do a little later. Lastly, the Eridia Exploring Co. developed a mine of that name that had by far the longest outcrop of any of those mentioned. It, too, was low-grade, and in consideration of the excessive charges for freight and supplies at that time, coupled with the great difficulty in transporting heavy machinery across the desert, this also was abandoned—temporarily, at all events.

The parent company proposed to construct a light railway, at a cost of $2500 per mile, from the Nile to this group of mines, all of which are within 60 miles of the river. The total length of railroad required to link the respective mines was 100 miles. This, with an equipment of three locomotives and a hundred wagons, involved an expenditure of approximately $300,000. The directors unfortunately were unable to convince the shareholders and others that the prospects were sufficiently attractive to warrant this further outlay before any returns would be forthcoming. This led to the abandonment of the scheme, and the closing-down of the Atallah, Eridia, and Semna mines at a time when two of them were looking promising.

In the course of a prospecting expedition undertaken by a colleague and myself in the fall of 1903 we discovered several other ancient mining-sites apparently as meritorious as any of the before-mentioned properties, but so far as I am aware these have remained untouched to this day.

On account of the scarcity of water, lack of transportation, and the presence of warlike tribes of Arabs, such as the Maazi, who are hostile to strangers, Egypt is no place for the individual prospector; and the Government, recognizing this, has wisely made laws that preclude any possibility of individual enterprise of this nature. In

the first place, it is necessary to obtain a large concession from the Government, legally called a 'prospecting area,' and to do so a considerable sum of money must be deposited with the Government as evidence of good faith. At a later date, if it is desired to work any particular mine seriously, a mining lease must be taken out and a yearly rental paid for the required number of acres. Also a royalty on the output is demanded by the Government. And here I may say that any relics, or *antika*, as they are called in Egypt, to be found during excavation, or otherwise, must be handed over to the authorities, who reserve the right to the possession of them.

The only present means of transport from the Nile or the Red Sea to the mines is by camel. The maximum load a strong camel will carry is about 500 lb., but the best contract that we were able to obtain from the Sheiks, who are the great stock and land owners of the country, was for an average load of 300 lb., for which the charge was $2.50. For this sum, however, they would carry back with them to the Nile a similar load free of additional cost. On the arrival of a caravan, no matter of how many camels, it was necessary to weigh the total load carried, and dividing this amount by 300, give the drivers a check for so many camels. This they would hand to the Sheik, their master, on their return, who in turn handed it to the mining company's agent at Keneh, for payment. Much haggling often ensued, as the Sheik would frequently insist that he had sent out, say 30 camels, and yet had only been given a check for perhaps 25 loads. This, of course, was all in the day's work, so to speak, for the Eastern mind is incapable of making a straight business transaction without bargaining or subterfuge, and for this due allowance had to be made.

It was estimated that by the construction of a light mine-railway of, say, 24-in. gauge, with steel rails, 16 lb. per yard, and steel ties, the cost of development at the mines would be reduced by about 30% at least. I think, however, that the figure quoted for construction, namely, $2500 per mile, was altogether too high. Unskilled labor cost at that time from 5 to 6 *piastres* (25 to 30 cents) per day, the men finding their own food, and, as a considerable portion of the track could have been laid with little or no preparation of the road-bed, and as there was an almost entire absence of tunneling, or even rock-cuts, I am of opinion that a much lower figure would have sufficed.

Atallah is situated 45 miles due east of Keneh, a large native village on the Nile, and lies at an elevation of 1600 ft. above sea-level. The auriferous veins traverse a country of coarse-grained gray granite, and strike northeast-southwest, having a dip of from 40 to 60°. At the south-western end of the outcrop the main vein passes into a formation of talcose schist and is intersected by a dike of intrusive rock. At the north-eastern end it terminates abruptly on the surface, the gray granite giving place to red felsite. A characteristic of the main vein is a repeated step-faulting that occurs below a depth of 250 ft. measured on the dip, the missing portion of the vein being found in the foot-wall. The gold-bearing quartz varies in color from white through various shades of blue, to almost black, in places. In addition to the precious metals it contains small quantities of lead, copper, iron, arsenic, and traces of antimony. A general sample of 75 lb. taken from all parts of the mine where the assays showed more than $10 in gold per ton, was assayed in London and gave a value of $125 in gold and 2.5 oz. of silver per long ton. Assays ranged from a few dollars up to about $200 per ton during the development period. The ancient workings on this vein were deep and extensive, but the maximum depth to which they were accessible was only about 200 ft. measured on the dip.

Semna Mine. The name 'Semna,' meaning in Arabic 'grease,' was probably applied to this mine by the Arabs on account of the greasy appearance of the schistose rocks that abound in the neighborhood.

As at Atallah, the main vein traverses gray granite, and, indeed, I may here remark, that this was invariably the case with all the good-looking ancient diggings that I visited in the course of our expedition. Quartz veins in the red granite, no matter how persistent, or how promising they appeared, were found to be barren of precious metal.

The main vein strikes almost due east-west and dips south at 60°. It consists of white quartz much stained near the surface with iron oxide, and carrying some chalcopyrite. It varies in width from 2 to 20 ft., having an outcrop about 1000 ft. long. It was opened up by three shafts—a vertical one at each end of the outcrop on the hanging-wall side of the vein, and an inclined shaft about midway between these sunk on the foot-wall side of the vein and about 20 ft. from it. Cross-cuts at intervals of 50 and 100 ft. in depth were driven from this to intersect the vein, which down to a depth of 160 ft. was found to maintain a regular dip, all the cross-cuts reaching the vein at practically the same distance from the shaft. Ancient workings were found to extend to a depth of over 100 ft. and little quartz was found in place until these had been passed.

The vertical shaft (No. 1) at the east end of the outcrop, intersected the vein at a depth of 75 ft. from the surface. It was found to be 12 in. wide with a gold value of $45 per ton. A drift east showed the vein to be gradually widening, until at 65 ft. from the shaft it was 15 ft. thick. For a length of 70 ft. the vein averaged 60 in. with an assay-value of $60 per ton.

The other vertical shaft (No. 3) was 770 ft. west of No. 1 and cut the vein at 80 ft. from the surface, but was continued to a depth of 123 ft. before driving was commenced, that being at the same level as the drift in No. 1. The east drift for 47 ft. showed a vein 30 in. wide with a gold-value of $8 per ton; the westerly drift for 33 ft. showing an average width of 22 in. assaying $7 per ton.

The inclined shaft (No. 2), subsequently used as a main hoisting shaft, gave considerable trouble for the first 50 ft. on account of heavy falls of rock from the hanging wall, which was weak. It was necessary, however, to have a shaft at this point, as, on account of the

ground rising steeply above the outcrop on the hanging-wall side of the vein, it was not feasible to sink a vertical shaft on that side. At a depth of 50 ft. the first cross-cut was driven southward to the vein, which it cut at a distance of 24 ft. Here the vein was 48 in. wide, assaying $5 per ton. Drifts east and west along the vein soon

A RESTING-PLACE ON THE DESERT.

reached old workings. Driving eastward for a distance of 80 ft. we found nine pillars, left by the ancient miners. These had an average width of 36 in. of ore assaying $40 in gold per ton. Westward at 23 ft. from the shaft, the vein was 55 in. wide, and assayed $18 per ton.

At 150 ft. from the surface a second cross-cut was driven south. This also cut the vein at a distance of 24

OPEN WORKINGS OF AN OLD MINE.

ft., the quartz being 24 in. wide and assaying $10 in gold per ton. Drifts east and west were started at the same relative level as the drifts in No. 1 and 2. At the time the property was closed down these had been driven almost the entire length of the outcrop, that is to say 1000 ft., and on the west side of No. 2 shaft a winze had been sunk to a further depth of 100 ft. or more.

ERIDIA MINE. The outcrop at this place was traceable for 1500 ft., the vein striking north and south. Its dip was 80° west and regular throughout. Considerable development work was done, the contour of the ground lending itself to the driving of adit-levels or cross-cuts. Although the vein was well defined and persistent no very high-grade ore was obtained during development, the best assay reported being $72 in gold, and the average perhaps $15. The width varied from a few inches up to four feet.

The following table shows the rates of pay for the different classes of native labor in and around the mines in Egypt at the time of which I write, and probably still obtaining there:

Unskilled labor (boys)	15 to 20 cents per day
Unskilled labor (men)	30 cents per shift
Hammer men	40 cents per shift
Carpenters	60 to 70 cents per day
Blacksmiths	60 to 70 cents per day
Foremen	75 cents per shift
Cooks and servants	*$20 to $30 per month

*According to whether speaking English fluently or not at all.

In every instance, with the exception of cooks and

GRANITE BASINS OF ANCIENT MILLS.

servants, the men provide their own food. Carpenters usually supply their own tools, preferring to use the kind to which they have been accustomed rather than the product of Western civilization.

The cost of living for white men is high, from $100 to $125 per month being a fair average for two men living together, exclusive of any allowance for mineral waters, alcoholic liquors, or tobacco. This is offset to some extent by the few requirements in the matter of clothing and the lack of spending facilities in the desert.

Of the ancient mining-sites mentioned above, on which no development work has been done, the largest was at a place called Abou Had, which lies almost directly south of Eridia, half a day's journey on camel-back. Here, among rugged hills, we found a large vein of white quartz striking northwest-southeast, intersecting gray granite. This vein had been worked by the ancients to a considerable extent, and near-by were ruins of old houses, in which were the remains of stone crushing-mills, and the usual accompaniments of these primitive mining camps. Samples taken from pillars of ore left by the ancients

usually showed a good prospect of free gold on panning.

Other places worthy of note that would, I think, repay investigation were the old mining-sites of El Rebshi and Um Hat. At the former there are many hundreds of pits each about 10 ft. deep sunk in the sand of the 'wady' or valley and often connected by low tunnels. These, so our guide informed us, had been sunk by the ancients to work an auriferous vein hidden beneath the sand. I think it more probable that they were dug for the purpose of obtaining placer gold, brought down from the neighboring mountains at a period in the history of Egypt when rain-storms were more frequent than at the present day.

At Um Hat we uncovered a small flat vein of copper-glance rich in silver. It was a contact-vein formed at the junction of red granite and talcose schist. This was the only instance of a deposit carrying either gold or silver that I ever observed in the red granite during my three years in the Arabian desert. Within a radius of several miles of this deposit the rocks were frequently seen to be stained a vivid green by copper carbonate. During the short time at our disposal we were able to make only a cursory examination of the locality, and, having no explosives with us, could do little more than clean the drifted sand from one or two of the old workings. In every instance the ancient miners had removed all the ore. I believe, however, that this district would repay the time and money spent in intelligent investigation, as there is every indication of it having been a prosperous copper camp in the past.

To sum up, this particular part of the eastern desert of Upper Egypt lying midway between the Nile and the Red Sea is well worthy of the description accorded to it by the ancient writer Diodorus, who says: "In the confines of Egypt there is a place full of rich gold mines out of which with much pains, and labor of many hands, gold is dug. There are, I believe, few places in the world so easy of access that exhibit such attractive prospects for the use of capital."

HOARDING OF GOLD. What becomes of the gold that disappears from circulation? There is at least one cause for the disappearance of gold that is of much greater importance than is generally supposed. This is hoarding of the metal in the form of coins. There are a great many people who fear to trust their money in banks or in the hands of any other person, and who shun every form of investment. They prefer the loss of the usual interest to the possible loss of the capital, consequently these people hoard their money, usually hiding it in out-of-the-way places. Some keep their gold in tea-pots, tin-cans, or other vessels; others bury it. This practice is more common abroad than in the United States, but is carried on to an astonishing degree almost everywhere. In Egypt, some years ago, a man died leaving $400,000 in gold, all of which was buried in his cellar. Another closed a deal for a piece of real estate for $125,000. Half an hour after the deed had been signed this man appeared with a string of burros carrying the coin which had been buried in his garden. Frequently after a fire the owner of the destroyed property begins placer-mining operations in the ashes in search of the coin he had hidden, but which he had been unable to rescue from the flames. In Spanish-speaking countries, silver as well as gold is commonly buried, particularly in those countries where the government is unstable.

Sharpening Drills for Seamy Ground

Sometimes a miner encounters seamy or broken ground, especially when it is composed of hard shattered rock says *The Coal Age*. The ordinary drill, sharpened as shown in Fig. 2, then does not give good results, for the

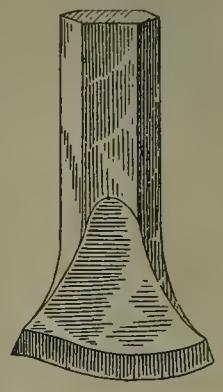

FIG. 1. A DRILL-BIT AS IT SHOULD BE SHARPENED.

FIG. 2. THE OLD WAY OF SHARPENING A BIT.

edge is frequently driven into a crack so that it is practically impossible to loosen or remove the drill.

This difficulty may be overcome by sharpening the drill as shown in Fig. 1, where it will be seen that the corners have been turned back so that the cutting edge assumes a curved outline. Such a drill-point as this will ride over ordinary cracks, and thus prevent sticking.

THE FIRST ROCK-BREAKER on the market in the West was the invention of Eli Whitney Blake, of New Haven, Connecticut. It was designed originally to break trap-rock for macadam. In 1861 it was introduced in the gold-mills of California, the first one being placed in the Benton mill, at what is now Bagby, on the Mariposa grant, the property of the Mariposa Mining & Commercial Company.

A HYDRAULIC-ELEVATOR will lift gravel to a height equal to about one-fifth the height of the pressure-column of water employed to operate it.

Western American Metallurgy

By A Visitor From Abroad

[The following review of metallurgical practice in the West consists of the notes made by a mining engineer, recently a visitor to the United States from a foreign country.—Editor.]

POWER. The outstanding feature noticed in this respect was the almost universal use of electricity as the motive power, and, wherever possible or feasible, the use of separate motors to operate individual machines or small groups of similar machines. Rarely I observed that, where it was for some reason not considered advisable to operate individual machines by separate motors, the most usual arrangement of the plant was that one large motor was provided for each complete section or unit of a plant, thus permitting any one section or unit of such a plant to be out of operation without interfering with the continuous working of other sections or units.

In passing, I may mention that electric mine hoisting-plants seem to be rapidly advancing in favor and to be replacing steam-driven hoists. At the Butte mines of the Anaconda company, in order to equalize the line load, it has been found to be more economical to operate hoists with compressed air under constant pressure on account of the cheaper conversion of the previously installed steam hoisting-plants. The Anaconda company makes use of hydrostatic receivers to maintain such constant air-pressure, and, it is said, with great resultant economy. On the other hand, smaller companies in the neighborhood are rapidly adopting electrically operated hoisting-plants.

The latest phase of electric hoisting is to be found in the Inspiration Copper Co.'s plant, where all the hoisting from two shafts is done by means of two electrically operated hoists working in tandem automatically. The record tonnage hoisted per 24 hours is about 19,000 tons. Also for raising and lowering men and supplies down to the 750-ft. level, an automatic elevator of the Otis type is in operation. The power-plant containing these hoists also houses the low-pressure air-compressors (100 lb. per sq. in.) for machine-drills and the high-pressure air-compressors (800 lb. per sq. in.) for underground mine-haulage by compressed air-driven locomotives. In this power-station is contained probably 7000 hp., yet the total attendance required is only two men per shift, one electrician and one mechanic.

Referring to general practice in driving flotation-machines, I noticed three methods of driving machines of the mechanical-agitation type. The Minerals Separation type of machines in the Anaconda plant are driven direct from motors coupled to the main driving-shaft, and thence through steel-bevel gearing to the vertical agitator-spindles, one motor being provided for each machine. In other plants visited the main driving-shafts were belt-driven from individual motors. In all cases bevel-gearing has replaced the former practice of quarter-turn belt-transmission between the main line-shaft and vertical spindles on machines of the Minerals Separation type. In the Janney type of machines the practice is to provide an individual vertical motor direct-connected to each spindle. The method usually adopted for driving rolls and Chilean mills was by belts from individual motors or from line-shafts. Tube-mills and conical mills are invariably driven by separate motors by means of gearing, and in the latest plants this gearing was of the double herring-bone or Wuest type.

MILL-HEATING. Steam-heating was the practice generally noticed—either by high or low-pressure steam. The most satisfactory method I saw was at the Timber Butte mill, where high-pressure steam is used to heat air that is distributed throughout the mill by means of fans. At the time of my visit the outside temperature was quite cold, but the mill throughout was maintained at an even and pleasant temperature, with the exception of the coarse-crushing plant, where no heating was provided.

LIGHTING. Electric lighting is universally adopted, single lights being provided for individual machines and large lights over an aggregate of machines. All mills are provided with the largest possible number of side windows, and in many of the larger mills roof-lighting is also employed to provide efficient illumination during the day-time over all machines.

BUILDING CONSTRUCTION. Steel framing covered with galvanized corrugated iron is almost universally adopted. In the latest mills I noticed that reinforced concrete was being largely used for the lower floors or sub-floors. Notable examples of this can be seen in the Timber Butte mill and the Miami mill.

FIRE-PROTECTION. Great attention is paid to this item. Where it is not possible to provide a large high-pressure reservoir, special automatic fire-pumps are in general use. The fire-protection service at the Timber Butte mill may be taken as illustrating the best modern practice.

MILL-SITES. As the principles underlying the selection of a suitable mill-site is one of considerable interest to my company, particular attention was paid by me to this question. I obtained the views of those in charge of the various mills visited on this subject.

The practically unanimous opinion was that

1. Wherever practicable the mill should be built as

close as possible to the point where ore is delivered from the mine.

2. The importance of selecting the mill-site high upon a hillside, so as not only to provide ample head-room for the impounding of mill-tailing, but also to provide ample additional elevation for future extensions of metallurgical plant or the subsequent need for future re-treatment of mill-products.

In many instances the older mills are now suffering inconvenience and additional expense owing to the failure originally to provide or to foresee fully the inevitable extra elevation for additional plant that sooner or later arose, due to improved metallurgical processes, or to accommodate a larger tonnage of tailing than was at first estimated.

It was also the general opinion that wherever possible it was better to select a site closer to a mine, and pump water therefrom if no other supply was available, than to allow the proximity of a water-supply to govern the choice of a mill-site.

Gravity sites, where possible, are universal, and in cases where insufficient slope is available, the deficiency of elevation is made up by extensive use of inclined belt-conveyors in the arrangement and placing of the coarse-crushing plant, thus allowing the rest of the mill to take full advantage of a gravity flow. In the case of the selection of the present site of one of the larger modern mills, we were informed that after the development of a sufficient tonnage of ore in the mine had been completed and the required milling plant designed, the selection of the site was decided entirely from a milling standpoint. The position of the main shaft was then selected to suit the mill, and it was placed so as to deliver ore immediately to the crushing plant.

In another instance, where the shaft was only some 300 ft. distant from the mill, a new shaft was being sunk to deliver ore more conveniently direct to the mill-bins. In other instances, where mines were situated more or less in the centre of a town and no possible immediately adjacent mill-site was available, there was no alternative to erecting a mill away from the mine; and in such cases the plants have been placed on a height, so as to provide ample elevation and tailing space for all future requirements so far as could be foreseen.

Transport of Ore. Where local conditions have not permitted the placing of the mill immediately adjacent to the mine, standard-gauge railway-cars of 50 to 60-ton capacity are used. Ample provision is made for ore-storage, both at the mine and the mill, thus overcoming any delay due to trouble on the railway.

Primary Rock-Breaking. These plants are situated either

(*a*) Immediately adjacent to the main shaft and often forming part of the head-frame structure.

(*b*) At the mill.

The primary rock-breaking, whether done at the mine or mill, is performed in two stages, the final product being reduced to suitable size for feeding to the grinding-plant ore-bins. The crushing machines comprise the following combinations, with intermediate screening of fine material:

1. Primary and secondary jaw-breakers.

2. Gyratory primary crushers and secondary jaw-breakers.

3. Gyratory primary crushers and roughing-rolls as secondary breakers.

4. Gyratory primary crushers and Symons disc-crushers for secondary breaking.

The combinations vary according to individual preference and the physical nature of the rock to be crushed. No. 4 probably represents the latest practice, but it is not to be advocated for soft or clayey ores. Neither would any combination including rolls be satisfactory for ores of this type. The final rock-crusher product is usually broken to pass a $2\frac{1}{2}$-in. opening, and at this size is delivered to the mill ore-bins.

Where No. 3 and 4 are applicable, it is found that a larger percentage of undersize is produced than with either No. 1 or 2.

All primary rock-crushing plants are provided with grizzlies to screen out the undersize before the primary breakers. In many instances secondary grizzlies or revolving screens are used between the primary and secondary crushers to screen out material already sufficiently crushed. Screens or grizzlies are not used after secondary crushing. The grizzly oversize is carried to the primary crusher in pan-conveyors, and belt-conveyors are employed for the crushed material and the undersize. Very little ore-sorting was noticed; probably the cost of labor makes ore-sorting unprofitable.

Crushed-Ore Storage. In plants that are placed at some distance from the mine, necessitating rail transportation of crushed ore, ample capacity of crushed-ore storage-bins is provided at both crushing plant and mill. Where the crushing plant is placed at or close to the mill, proportionately larger crushed-ore storage-bins are provided at the mill.

It is interesting to note that the recently erected plant at the Alaska Gold Mines, whose plant is situated on Gastineau Channel, Alaska, includes large-capacity underground storage-bins situated between the rock-crushing plant and the mill proper. The transportation of ore between the underground bins and the mill ore-bins is effected by means of belt-conveyors on a 1% down-grade, which slope is almost sufficient to make the belt-conveyor self-acting. The Alaska Gold Mines plant has a capacity of 8000 to 10,000 tons per day and is considered to embody the most modern practice.

Primary Grinding. Ball-mills continue to come into favor. The straight cylindrical type is now being favorably considered as against conical mills. In cases where the ore is clean and free from adhering and sticky material, rolls have been largely used, and in many plants are considered to be the most efficient primary-grinding machines down to about 8 to 12-mesh. The trend of recent practice inclines to the use of ball-mills of large capacity, operating them in direct closed circuit with a classifier, or operating two such mills in series multiple

circuit with classifiers, that is to say, each ball-mill receives initial feed and the oversize from the classifier produced in mill *A* is delivered to mill *B* for further grinding and the reverse, thus establishing a closed circuit. This is the practice followed at Inspiration.

It is noted that in the large milling plants of the Utah Copper Co. rolls were formerly used exclusively for primary grinding. At the time of my visit experiments were being conducted on two sections of the Arthur mill with a view to comparing the relative efficiency of the Marcy mills in closed circuit with classifiers, producing a finished product, as against the practice of primary grinding in rolls and secondary grinding in Chilean mills. The general impression prevailing at the time was favorable to ball-mill grinding. In regard to that, the general opinion seems to be that for ball-mills used as preliminary grinders, when using balls of 5-inch diameter, the feed need only be crushed to pass a 3-in. ring. Finer feed on the large Marcy mills has not increased the output; on the contrary, reduced output has in more than one case been the result. It is advantageous apparently that the ball-mill feed should contain a certain proportion of coarser ore.

Secondary Grinding. For grinding down to about 30-mesh, high-speed Chilean mills are largely in evidence, but competitive tests were being made in several plants to prove the efficiency of cylindrical ball-mills in this field and opinion seems about fairly evenly divided as to the relative merits of these machines, with, if anything a balance in favor of cylindrical mills. Anaconda formerly used Chilean mills for secondary grinding, but since the introduction of the flotation process into that plant the management has entirely discarded Chilean mills in favor of conical mills. It seems more than probable that in new plants cylindrical or conical mills will entirely supersede Chilean mills for secondary grinding, and so far as one can judge from the various opinions expressed, there is little to choose between the relative merits of modern-type short cylindrical mills as against conical mills.

Re-grinding. For re-grinding material to pass a 65-mesh screen, or finer, both conical and cylindrical mills are almost universally used. Competitive tests were in progress at several mills, both between cylindrical and conical mills, and also between the efficiency of pebble-grinding in silex-lined mills as against metal lining using steel, manganoid, or other types of balls. The preponderance of evidence seems to incline to the use of steel lining and metallic balls of a maximum diameter of three inches on account of increased output and lower net consumption of grinding media. The present scarcity of pebbles is also a consideration. As in the case of secondary grinding, opinion seems fairly evenly balanced between the relative merits of the two types of mills. In passing, it is of interest to note that the Anaconda re-grinding plant was equipped with 10-ft. diam. conical mills with silex linings, but owing to excessive pebble consumption (14 lb. per ton ground) caused chiefly by breakage due to the large size of the mills, the internal diameter has been reduced to 7 ft. 6 in. by wood lagging faced with the Cascade type of steel liners; and chrome-steel and manganoid balls are now in use.

During my journey I had little opportunity of visiting all-sliming grinding plants, but I believe that the longer type of cylindrical mill is still pre-eminent in this field. In using balls for re-grinding, these should not exceed three inches diameter, and in many cases preference is given to a maximum diameter of 2½ or even 2 in., when handling *minus* ¼-in. feed, and to operate the mills in closed circuit with classifiers, and a heavy return-oversize feed, even up to 300%, and particular attention is paid to pulp consistence. It should be noted that all the foregoing remarks on grinding have more particular reference to recent copper-milling practice as distinct from purely gold-milling practice.

Ore-Conveying. For conveying coarse ore inside a mill steel pan-conveyors are almost uniformly used. In the plants I visited fine ore was without exception conveyed on rubber belts, and during the trip I have seen many miles of such equipment, some of the belts being of considerable length. Belt-trippers were in universal use. Hand-trucking inside mills was not observed in any one instance. Fine ore is elevated by belt and bucket-elevators, and modern practice has increased the speed of bucket-elevators with a general increase in the diameter of the head-pully. Pulp is elevated by bucket-elevators, centrifugal pumps of various types (Cripple Creek practice), air-lifts, and diaphragm-pumps. Bucket-elevators represent the best practice in concentrating mills and diaphragm-pumps are usually employed in cyanide mills in conjunction with counter-current decantation where it is necessary to regulate accurately the rate of pulp-transference. For the general elevation of pulps, bucket-elevators seem to hold the field, air-lifts being usually classed as unreliable and likely to cause trouble in operation.

Classification. Dorr and Akins machines are mostly used. Where accurate classification of slime is required, the Dorr machine is preferred, that is, where it is aimed to produce a slime free from oversize. On the other hand, where sand is required free from slime, the Akins machine holds the field. This machine is also generally used for dewatering coarse tailing. In classification for table-feed the Richards-Janney and Richards hindered-settling and the Deister cone-baffle classifiers are in use. At Anaconda a special classifier has been developed to suit local requirements, namely, to deslime roughing-table feed, but this was developed prior to the perfection of the mechanical classifier. In some mills double-cone classifiers are still in use, but these seem to be rapidly going out of fashion.

Thickening and Dewatering. For this class of work the Dorr thickener is generally employed.

Filtering. The Oliver filter (and the Portland form of the same filter) is preferred when only dewatering is aimed at, but when, as in cyanide-plants, it is necessary to displace gold-bearing solution contained in the filter-cake in order to obtain maximum recovery, Butters and Merrill filters are in use, the former being stated to be

preferable on account of lower initial cost and greater flexibility of operation. For dewatering flotation-froth, the Oliver (or Portland) filter is in most common use and in such plants as I visited, where other types of filters were in operation, those in charge were as a general rule about to replace these with Oliver filters or would like to do so.

THICKENING AND DEWATERING FLOTATION-FROTH. As stated above, Dorr thickeners and Oliver filters represent the latest practice. From 25 to 40 sq. ft. of settling-area in the thickening-tanks are about the usual limits allowed for dewatering one dry ton of flotation-concentrate per day. To dewater to a consistence of 60% solid in the underflow product, tanks of a minimum depth of 12 ft. are used, and this consistence—about 60% solid—seems to be most favored by those operating continuous filters. Such a consistence of concentrate is enough to hold the coarser particles in suspension without excessive agitation in the filter-tank. Under these conditions, continuous revolving filters have an approximate average capacity, when handling mixed table and flotation-concentrates, of one dry ton of concentrate per four square feet of filter-area per 24 hours. In the case of flotation-concentrate alone eight square feet is a normal allowance, and this figure varies considerably with the fineness of the concentrate; where heavier oils are used as flotation reagents, it may run as high as 12 ft. for all *minus* 200-mesh material at 60% solid consistence. The general vacuum maintained when handling mixed concentrates seems to be within 6 and 8 in. of mercury and the cake produced varies from $\frac{3}{4}$ to $1\frac{1}{4}$ in. thick at normal speeds. The moisture in the cake discharged is generally about 13%, but in more favorable cases, where coarse concentrate predominates, as low as 9% of moisture is in some plants being maintained. On the other hand, in plants handling solely flotation-concentrate of a fine nature, where heavy oil is used as one of the reagents, the vacuum maintained is as high as 25 in. and a cake only $\frac{3}{8}$ in. thick is being produced, containing 18 to 22% of moisture. The approximate consumption of power on an Oliver filter, 12 ft. diam. by 11 ft. 6 in. long, averaged in the various plants about 30 hp. when Roots exhausters were used to produce the vacuum (in the case of low vacuums). In the case of a high vacuum being necessary, dry-vacuum pumps are employed. The scrapers for removing the cake in the 11 ft. 6 in. filters have to be supported in the centre on account of the weight of concentrate they remove.

FLOTATION PRACTICE. The Minerals Separation type of machine seems to be giving generally the best results and operating with the minimum amount of attention. After having had an opportunity of seeing the Janney, Callow, and Gahl machines in operation at different mills, it would appear to me that on ores that are floated with difficulty the mechanical type of machine is to be preferred. There has been steady progress in the design of the M. S. type of machine—the original form using the quarter-turn belt-drive is seldom found; recent machines having adopted a bevel-gear drive. To equalize the thrust in the geared machines the general practice is to use left and right-handed impellers in adjacent agitation-cells, at the same time ball-bearing thrust-washers are likewise in use between the driving-gear and the bearing.

The most recent construction employs a concentric coupling for each two boxes, so that, if repairs are needed, only the length of shafting over two boxes need be removed; at the same time these couplings compensate for any shrinkage or expansion of the wood-work of the machines without putting undue strains on the moving parts. The gear-boxes are provided with removable bottoms, and the vertical spindle-bushings are provided with stuffing-glands to prevent leakage of lubricating grease from the gear-boxes. Cut-gears are used made either of steel or phosphor-bronze. The latter are to be preferred; they give better mechanical efficiency and smoother running, although adding considerably to the first cost of the machine.

The latest type of drive for the M. S. machine is to have the motor direct-connected through a flexible coupling to the main shaft. This gives the most efficient drive, but it does not allow of any change of speed, should such be necessary, and it also requires far heavier construction to support the motor when it has to be built onto the machine.

Regarding the respective merits of the mechanical-agitator type of machine and the pneumatic type, it has always been claimed that the pneumatic type was more economical in power consumption. This contention was not confirmed by the engineers in charge of the competitive tests at several of the mills I visited, where after the most detailed investigation the M. S. type of machine was finally adopted.

The general view held by those I have consulted who are using, or who are familiar with the operation of pneumatic machines, is that this system fails to float coarse sulphide particles, say, plus 65-mesh and coarser. This opinion is held by some to be erroneous and the Inspiration and Miami, where the grinding is through a 48-mesh screen, are quoted. At Inspiration the flotation-plant is followed by concentrating-tables for the coarser sand and at Miami concentrating-tables precede the flotation-cells, and only the finer sand and slime are floated. The Inspiration tests on the ordinary pneumatic cell apparently showed that the pulp passed too rapidly through the machine, and to overcome this defect a special machine was designed, which, while following the general pneumatic principle, has provided means to overcome this objection, namely, by introducing regularly adjustable baffles, and decreasing the inclination of the air-blankets forming the bottom of the machine to $\frac{1}{2}$ in. per foot. The total length of the roughing-machines introduced at Inspiration is 51 ft., divided into 16 compartments, each 3 ft. long.

According to the advocates of the pneumatic machine, successful flotation depends not so much on the amount of agitation, as in the selection of the most suitable oil mixture, and its proper emulsification, the reagents

used, the choice between acid, neutral, or alkaline circuits, and temperature.

A great deal of attention is now being paid to a new phase of flotation, generally termed 'film-flotation,' that is, the coating of oxidized ore with a film of sulphide, produced by added reagents, such a film giving the oxidized minerals the flotation properties of the sulphides. I learn that one group is gradually acquiring all the existing patents covering this phase of flotation that are for sale, and are now watching developments until their process is perfected, when they will proceed against infringers.

These processes, I understand, apply particularly to the use of sulphuretted hydrogen, alkaline sulphides and poly-sulphides, together with the use of an alkaline circuit.

In my opinion the Janney machine does not appear to show any advance over the Minerals Separation machine —rather the reverse—as the higher speed of the former requires approximately 10% more power in units of equal capacity; the average peripheral of the Janney impeller being about 2000 ft. per minute, as against an average of, say, 1400 ft. per minute in Minerals Separation practice. For instance, in 600-ton capacity machines, the Janney was consuming 9.1 hp. per spindle as against 8.1 hp. per spindle for Minerals Separation machines. The latest development of the Janney machine is the provision of an air-blanket in the last cells of the machines, in order to reduce the copper content of the final tailing and produce a low-grade middling for re-treatment.

In treating large tonnages by flotation, a considerable diversity of opinion exists as to whether it is more profitable to use the same number of cells in series or in multiples. For instance, a plant consisting of one machine having 16 agitation-boxes, or two machines each having eight agitation-boxes, and each handling one-half of the feed. In the first instance, to draw off a clean concentrate from the first four or six boxes and re-treat the middling from the remaining boxes either by returning it to the original feed or re-treating in a separate machine. In the second instance, to draw off a clean concentrate from the first two boxes of each 8-box machine, and re-treat or return the remaining froths.

In this connection the latest practice at the Timber Butte mill is of great interest. At this mill the flotation-plant consists of three machines:

(1) A primary roughing-machine of 19 agitation-boxes in series.

(2) A middling-machine of 5 boxes, also in series.

(3) A re-cleaning machine of 8 boxes, in two multiples of four boxes in each series.

In spite of the success obtained by this arrangement, it is now intended to erect a second flotation-plant in this mill, in which the roughing-machine will consist of 20 boxes operating in two multiples of 10 boxes each.

Flotation Oils and Reagents. The general tendency is to use the cheapest and crudest types of oil, and such as are obtainable in the greatest quantity. One of the initial difficulties of large flotation-plants is the provision of an uninterrupted supply of the particular oil required; and this question of supply is taken into more serious account than the actual cost of the oil. Admixtures of wood-creosotes and coal-tar (and acid) are the most common compositions used on the Minerals Separation machines. Pine-oils and reconstructed oils are generally used on the Janney machines, and these types of oil at the present time are costing more than the wood-creosote mixtures, and as far as I am able to judge, the amounts used per ton treated are about the same. The main variation in the creosote and tar mixture lies in

MAP OF ARIZONA, SHOWING SOME OF THE LOCALITIES MENTIONED.

the amount of sulphuric acid used. Naturally, the use of acid on ores containing a limestone gangue is impossible. Sulphuric acid seems to be beneficial in obtaining a higher-grade concentrate from ores that contain alumina as a kaolin slime, probably due to the production of aluminum sulphate, which acts as a flocculant.

I heard a great deal about heavy top-sulphur oils, reconstructed pine-oils with resin added, and an artificial poly-sulphide of lime termed 'calura' (sodium hydrate, sulphur, and lime), also sodium sulphide, and other reagents, but, so far as results show, the wood-creosote and tar (and acid) mixture is more than holding its own.

In Hancock county, Maine, the Holman Molybdenite company is developing a large deposit of molybdenite, which is expected to yield 1% MoS_2. A 100-ton mill is proposed, to recover 1 ton of molybdenite concentrate daily.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

ONE POUND of molybdenum will produce approximately the same results as two or three pounds of tungsten in making alloy-steels.

GOLD RECOVERY of the Cam & Motor mill in Rhodesia, treating an ore containing antimony and arsenic by roasting and cyaniding, was 83% during 1916.

CORD-WOOD at the Walker copper mine, Plumas county, California, is piled high, leaving 'drifts' and 'cross-cuts' inside so that the wood may be 'back-stoped' under the heavy snow which falls in the district.

AUTOMOBILES have been put to many uses by miners, from hoisting ore to driving a crusher. For sawing wood, we are informed that by attaching a pulley to the rear axle of an auto, power may be transmitted to a saw-bench by belt. The pulley is put on the shaft in place of one of the floating axles, and held in place by a collar fitted between the differential housing and floating axle casing.

MAGNESITE occurs in nature associated with basic magnesian rocks of the peridotite series, such as olivine or its altered form, serpentine. Two distinct types of deposits are known. The more important is the vein or lens type of orebody as distinguished from those deposits known to be of sedimentary origin. The problem is not so much one of the origin of the magnesite itself, as of the origin of the carbonic acid and magnesium of which the mineral is composed.

ALUM is used to purify the water in reservoirs. The alum-cake is made by treating pulverized bauxite with sulphuric acid. These two ingredients are mixed cold and no water is added. The mixture is stirred for five minutes, and is then discharged into a pit in which the alum crystallizes in cakes three to four inches thick. The cake-alum is successfully employed for water purification in place of the liquid alum-syrup previously used for the same purpose.

LEAD-SLAG is a silicate of iron and lime, and varies in color according to its composition. Usually it is black, the darkest being that containing much iron, though when a small amount of ferric oxide (Fe_2O_3) is present it may have a reddish or a greenish cast. Lime has a tendency to make the color lighter, giving the slag a dull stony appearance, and manganese in large amount produces a reddish or amethystine tint, and when the manganese is associated with 20% or more of lime the slag often assumes a resinous appearance resembling zinc-blende. When zinc is present together with some manganese and much silica, the slag looks like porcelain or some varieties of obsidian. Slag that is black and lustrous owes its appearance to an excess of iron, and very silicious slags have a greenish color.

MANGANESE DEPOSITS, estimated to contain 250,000 tons of ore assaying 87% MnO_2, are being exploited on the Nicoya peninsula on the west coast of Costa Rica, Central America. The ore will be taken to Philadelphia by way of Panama Canal. Three new steamers are being built for the trade. The Crespi, Keith (United Fruit Co.), Marshall (Dunbar Furnaces, Philadelphia) interests are behind the project.

WATER-WHEELS of the old-fashioned type, commonly known as over-shot wheels are still in use in some parts of California. There is one near Quincy, in Plumas county, 72 ft. in diameter that was built in 1868, repaired in 1880, and is doing good service still. It supplies power to a saw-mill. In the early days of quartz mining in California over-shot wheels were used as a means of power to run many mills, and a few of them may yet be seen at isolated mines.

PHOTOGRAPHS are a valuable aid to a description, particularly that of mines and metallurgical plants. When taking photographs the man with the camera should aim to obtain pictures that will show to the best advantage the object that he wishes to illustrate, giving little heed to artistic effect. Too many forget this, or do not realize that it is not so much a pretty picture that is wanted as one that will show just what is to be illustrated. When taking pictures of open-work structures, such as head-frames or machinery standing out of doors, choose a dull day when the sun does not cast sharp shadows, for these confuse the object and much of the value is lost of what may otherwise have been an excellent picture.

BULKHEADS in mines must be constructed with great care if they are intended to resist the pressure of a high column of water. The higher the hydrostatic head to be resisted, the greater the need for care in the selection of a suitable place for bulkhead, and the more important is caution in the choice of materials and strict supervision in construction. The mistake is occasionally made of placing a bulkhead in a part of a mine where the rock is much shattered, from natural causes. In one instance, after the completion and closing of a bulkhead, and the water had accumulated behind it with increasingly greater pressure as the hydrostatic head got higher, the water spurted into the cross-cut on all sides—not through the bulkhead, but through the fissures in the rock—rendering the structure useless. The rock was andesite, which was fissured from natural causes and shattered by blasting. The choice of this site for the bulkhead was unfortunate, and it may be that the result could not have been anticipated. However, a knowledge of what occurred in this instance may be of service to others who find it necessary to construct a bulkhead underground.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

MEXICO CITY

REMARKABLE CONSTITUTION ADOPTED BY CARRANZA'S MEXICAN ASSEMBLY, WITH EXTRACTS THEREFROM.

The work of the Constituent Assembly was completed at Querétaro on January 31, and published as the new Federal Constitution on February 4. The Assembly was made up of 254 deputies, each deputy accompanied by a *suplente* (substitute), according to Spanish custom. The deputies were supposed to be equitably representative of the entire Mexican nation, but the representation was haphazard and unequal, whether calculated on the basis of States or of the density of population. Many deputies were not resident nor even acquainted with the districts from which they were supposed to hail. The November election, by which they were chosen, was mainly a farce. Most Mexicans, knowing that the results were pre-arranged, did not bother to go to the polls, and in the few districts where some popular resident might chance to receive a large vote, he was out-voted by the other municipal *presidentes* (mayors), who made up the returns for the official candidate to suit themselves, often without so much as consulting the ballot-boxes. Such an election is nothing new in Mexico. Indeed, the only election on record which was in any degree a genuine expression of the public will was that under Madero in 1912. The few deputies not of the officially appointed type who appeared at Querétaro with proper home credentials of election were turned over to the tender mercies of the Credential Committee and rejected as 'reactionaries.' This fate befell not only lifelong Liberals, who may have committed the unpardonable sin of holding office under Huerta or the Convention, but also certain independent Liberals who are actually working for Carranza.

That the Constituent Assembly is a hand-picked body of Carrancista partisans and not, as advertised to the world, a "duly-elected convention of representative Mexicans" is, perhaps, of less interest than the character of the new constitution which it framed. This document contains some 20,000 words, hence I will translate only portions of greater interest to foreigners, as involving their persons and rights. The dangerous influence of the anti-foreign and anarchist factions, as prophesied in my letters of January 29 and October 21, 1916, has now become manifest. These factions have introduced into the fundamental law of Mexico their rabid prejudices in the form of many pernicious projects. The Assembly was opened on December 1 by Carranza himself, who presented to it a draft of the proposed constitution. This draft had for its base the old constitution of 1857, with changes, mostly added with the object of legalizing the innumerable arbitrary military decrees which have been the most distinctive feature of the Carrancista régime to date. It is only fair to Carranza to state that his draft was much less anti-foreign and anarchistic than the constitution as finally approved.

Chapter I of the new constitution deals with 'individual guarantees.' It is an expansion of the old constitution, forbidding slavery, peonage, monastic vows, arbitrary imprisonment, confiscation of private property, excessive penalties for crime, retro-active legislation, or interference with the freedom of speech, press, travel, correspondence, occupation, domicile, or worship. The first 26 articles of Chapter I are similar in design to the first ten amendments to the Constitution of the United States, and constitute a bill of rights in a somewhat more detailed form. Religious acts are, however, forbidden outside of churches or homes, and in time of war the military forces are allowed to demand lodging, equipment, food, or loans from civilians, on terms established by martial law. The following quotations are of prime importance to foreigners contemplating business enterprise in Mexico.

"Art. 27. The ownership of lands and waters inside of the national boundaries pertains originally to the Nation, which has had and has the right to transmit control of them to private individuals so as to constitute private property. This latter cannot be expropriated except for public utility and after indemnification.

"The Nation will always have the right to impose on private property the regulations dictated by public policy, and also to control natural resources capable of appropriation in the interests of their conservation and of an equitable distribution of the public wealth. For this purpose the necessary measures will be taken for the subdivision of the *latifundios* (great estates), for the development of small holdings, for the creation of new centres of agricultural population along with their indispensable lands and waters, for the encouragement of farming, and for prevention of the destruction of natural resources and of damage to them which would injure the rights of society.

"Towns, villages, and communities which lack lands or waters, or have an insufficient quantity for their inhabitants' needs, may acquire them by taking such from adjoining properties, but they must constantly respect small holdings. Thus are confirmed the gifts of lands which have been made to date, according to the Decree of January 6, 1915. The acquirement of private properties necessary to attain the above objects will be under sanction of public utility.

"To the Nation pertains the direct ownership of all minerals or substances which, in the form of veins, beds, masses, or deposits, constitute bodies whose nature is distinct from the enclosing rock, such as the minerals yielding the industrial metals and metalloids, deposits of precious stones, of amber, and of salts formed directly from marine waters, the products of rock decomposition requiring underground extraction; the phosphates utilizable as fertilizers; combustible solid minerals, petroleum, and all other hydrocarbons, whether solid, liquid, or gaseous.

"The Nation also owns the following waters: its territorial seas within the limits fixed by international law; the lakes and lagoons of the seacoast; the natural interior lakes, which are directly connected with constant rivers; the principal rivers or flowing streams from the point where the first permanent water starts toward its mouth, whether they enter the sea or merely cross two or more States; the intermittent rivers which cross two or more States in their principal part; the rivers, streams, or creeks when they form a national or State boundary, and the streams flowing from mine drainage. The beds, channels, and banks of the aforementioned waters are also national property within the limits fixed by law. Any other stream not included above will be considered an integral part of the private property which it crosses, but the utilizing of waters when they pass from one estate to another will fall under the rule of public utility, subject to regulations dictated by the States.

"In the cases listed in the two previous paragraphs, the ownership of the Nation is inalienable and imprescriptible,

and the Federal government may only grant concessions for their use to individuals, or to civil or commercial companies conforming to Mexican laws, on the condition that they install regular work for the exploitation of the elements in question, and comply with all the requirements of the laws.

"The ability to acquire control of the lands and waters of the Nation will be governed by the following rules:

"I. Only Mexicans, by birth or naturalization, and Mexican companies, have the right to acquire control of lands, waters, and their accessories, or to obtain concessions for exploiting mines, waters, or combustible minerals in the Mexican Republic. The Government may concede the same right to foreigners, provided always that they agree before the Secretary of Foreign Relations to consider themselves as nationals with respect to such property, and not to invoke the protection of their home governments for anything relating to it, under penalty of forfeiting to the Nation whatever they may have expended on their concessions. In a belt 100 km. (60 miles) wide along the frontiers and 50 km. wide along the seacoasts, foreigners may not acquire property in lands or waters under any pretext.

"IV. Commercial corporations issuing shares may not acquire, possess, or operate rural estates. Such corporations, which are formed to exploit any manufacturing, mineral, or petroleum industry, or for any other non-agricultural purpose, may acquire, possess, and operate lands only to the extent which may be strictly necessary for the installation and performance of their indicated objects, as determined by the Executive of the Nation, or of the States, as the case may be.

"V. Duly authorized banks, conforming to the banking laws, may loan money on urban or rural property, according to law, but may not own or manage more real estate than is absolutely needed for their own use, except temporarily during the brief time allowed by law, in so far as such properties serve as security for loans.

"VI. Co-ownerships, villages, congregations, tribes, and other popular corporations which *de facto* or by law preserve a communal organization, will have the right to work in common the lands, forests, and waters which they own, or have, or will recover by the law of December 6, 1915. Meanwhile, the law will determine the manner of subdividing these lands in future.

"VII. * * * The laws of the States and Federation, in their respective jurisdictions, will fix the cases where the expropriation of private property may be judged a public utility; and in accordance with such laws the Executive will issue the corresponding decree. The price fixed upon as indemnity for the thing expropriated will be based on its assessed value in the public tax-office, plus 10%, whether this value has been declared by the owner or tacitly accepted by him as the base for paying the taxes. The excess value which the private property may have acquired through betterments made since the last assessment, will be the only part of the price which will be subject to expert appraisal and to judicial determination.

"Art. 28. In Mexico there can be no monopolies of any kind, nor exemption from taxes, except the coinage of money, the telegraph, the radio-telegraph, and the issue of notes by a single bank, which monopolies will be controlled by the Federal government. There are also excepted the copyrights granted to authors and artists for the reproduction of their works, and the patents allowed to inventors for their improvements in the arts.

"Consequently, the law will punish severely, and the authorities will effectively prosecute, all concentration or cornering in the hands of one or of a few, of articles of necessary consumption, with the object of raising prices; every act which tends to overcome free competition in production, industry, commerce, or public service; every agreement or combination, in whatever manner made, of producers, manufacturers, merchants, or common carriers, or of any other public service, to avoid competition and oblige consumers to pay exaggerated prices and in general, whatever constitutes an exclusive advantage in favor of one or of several persons, and prejudicial to the general public or to some social class.

"Workmen's unions, organized to protect their own interest, will not be deemed monopolies; neither will associations or co-operative societies of producers who, in defense of their own and the general interest, sell directly in foreign markets the national products which are the principal source of wealth in the producing region and which are not articles of first necessities, be deemed monopolies.

"Art. 33. Those are foreigners who do not possess the requisites for citizenship, as set forth in Art. 30. They will enjoy all the individual guarantees afforded by Section I of the present Constitution, but the Federal Executive will have the exclusive right to eject from Mexico, immediately and without trial, any foreigner whose presence he may judge to be unwelcome. Foreigners must not in any manner mix up in politics."

Under 'Title VI,' headed 'Concerning Labor and Social Prevision,' we have, perhaps, the most unusual and interesting articles of the whole document, as follows:

"Art. 123. The Federal Congress and the State Legislatures will expedite labor laws adapted to local needs, but harmonious with the following rules which will govern the labor of workmen, day laborers, clerks, domestics, and artisans, and in general all labor contracts:

"I. The maximum duration of a day's work will be eight hours.

"II. The maximum duration of night work will be seven hours. All unsanitary and dangerous work is prohibited for all females and for youths under 16 years of age. For both classes all night work in factories is prohibited, and in commercial houses all work after 10 p.m.

"III. Youths between the ages of 10 and 16 years will have as a maximum day's work a period of 6 hours. The employment of children under 12 years of age may not be the subject of any contract.

"IV. For each 6 days' work the laborer must be allowed at least one day of rest.

"V. Women, during the three months previous to childbearing, must not be given physical tasks which require any considerable exertion. For the month following a birth, a mother must be given a vacation, with full pay, and afterward be given back her job with all the rights pertaining to her under her contract. During the period of lactation, a mother must be given two extra rest periods of half an hour each, in which to suckle her infant.

"VI. The minimum wage which must be paid a worker will be what is deemed sufficient to satisfy the normal needs of his life, his education, and his honest pleasures, considering him as head of a family. In every enterprise, whether agricultural, commercial, manufacturing, or mining, the workman will have the right to share in the profits, which will be fixed according to sub-section IX.

"VII. For equal work, the same salary must be paid, without regard to sex or nationality.

"VIII. The minimum wage will be exempt from embargo (garnishee), compensation, or discount.

"IX. The determination of the minimum wage, and of the share of the profits, referred to in sub-section VI, will be done by special commission formed in each municipality, subordinate to the Central Board of Conciliation established in each State.

"X. Wages must be paid in legal money, and no substitutes, such as merchandise, tokens, counters, or such like, will be permitted.

"XI. When, from unusual conditions, the legal hours of daily work must be exceeded, there must be credited as wages for the overtime 100% above the normal rate. In no case must the extra work exceed three hours daily, nor must there

be a recurrence of overtime work. Males of less than 16 years and women of no age will not be permitted to perform this class of work.

"XII. In every enterprise, agricultural, industrial, mining, or any other, the owners must provide the workmen with comfortable and healthy houses, for which they may charge rents which must not exceed ½% monthly of the value of the real estate. Also, they must install schools, hospitals, and other normal public services of the community. If the enterprise is situated within a town and employs more than 100 people, it will rest under the first of the above-mentioned obligations.

"XIII. Furthermore, in villages where the population exceeds 200, there must be reserved a space of ground not less than 5000 square metres (1¼ acres) for the establishment of public markets and of other buildings for municipal service and recreation. In all such villages the establishment of drinking saloons and gambling rooms is prohibited.

"XIV. Owners will be responsible for the accidents and the professional illnesses of the workmen incurred by reason of or during the performance of their duties; owners must pay the corresponding indemnity fixed by law, whether the results have been death or simply temporary or permanent incapacity for work.

"XVI. Both employers and workmen may organize for mutual protection by forming unions, professional societies, etc.

"XVII. The laws will recognize strikes and shut-downs as the respective rights of workmen and employers.

"XVIII. Strikes will be legal when they have as their object the equilibrium of the different productive factors and the harmonizing of the rights of labor and capital. In the public service, workmen must give 10 days' notice, before striking, to the local Board of Arbitration. Strikes will be deemed illegal only when the majority of the strikers use violence against people or property, and in case of war when the workmen belong to establishments or services dependent on the Government. Workmen in the military factories of the Government are not included under this regulation, because they are part of the national army.

"XIX. Shut-downs will be legal when an over-production makes it necessary to stop work in order to maintain prices at a payable figure, and when the shut-down has first been authorized by the Board of Arbitration.

"XX. The differences or conflicts between capital and labor will be subject to the decision of a Board of Conciliation and Arbitration formed by an equal number of representatives of the workmen and of the employers, with one representative of the Government.

"XXI. If the employer refuses to submit his differences to arbitration or to accept the award of the Board, his contract with labor will be annulled, and he will be obliged to indemnify his workmen to the extent of three months' salary, and to assume any responsibility resulting from the conflict. If the workmen decline arbitration their labor contract will be terminated.

"XXII. The employer who discharges a workman without just cause, either for having joined a labor union, or for having taken part in a legitimate strike, will be obliged, at the option of the workman, to either restore his job or to indemnify him in an amount equal to three months' pay. Also the employer will rest under this obligation when a workman quits because of lack of good faith or because of bad treatment on the part of the employer, whether toward himself, toward his wife, parents, children, or brother. The employer is similarly liable if the bad treatment proceeds from clerks or relatives who work with his consent or tolerance.

"XXIII. The credits of workmen for salary or wages performed in the previous year and for indemnities will have preference over all other debts, in case of insolvency or bankruptcy.

"XXIV. For debts owed by workmen to their employer, his associates, relatives, or clerks, only the workman himself will be responsible, and in no case and for no reason may payment be demanded from any member of his family; nor may payment of such debts be demanded for the amount of a single month's salary due the workman.

"XXV. The service of finding jobs for workmen will be performed gratis and may be carried on by municipal offices, labor exchanges, or by any other official or private institution.

"XXVI. Every contract for labor outside of Mexico made between a Mexican and an employer living abroad must be legalized by the competent municipal authority and visèed by the consul of the nation whither the workman is to go; with the understanding that, besides the usual conditions, it shall be clearly provided that the expense of re-patriation shall be borne by the employer.

"XXVII. The following conditions, even if written in the contract, will be void and will impose no obligation upon its signers:

"(*a*). Those which stipulate a length of day inhuman for the kind of work to be performed.

"(*b*). Those which fix a wage which is not remunerative in the judgment of the Boards of Arbitration.

"(*c*). Those which fix a time longer than one week for the payment of wages.

"(*d*). Those which designate an amusement hall, a restaurant, a café, a tavern, a saloon or a retail shop as the place for the payment of wages, except for employees of such establishments.

"(*e*). Those which imply a direct or indirect obligation to acquire the articles of consumption in certain stores or places.

"(*f*). Those which allow the retention of wages by fines.

"(*g*). Those which constitute a renouncement by the workman of the indemnities to which he is entitled for the accidents of work, professional sickness, and damages caused by an unfilled contract or by dismissal.

"(*h*). All other stipulations which may imply renouncement of any right secured to a workman by the laws for his protection and aid.

"XXVIII. The laws will determine the goods forming a 'family patrimony'; this patrimony will be inalienable and cannot be subject to liens or *embargos*, and will be transmissible by will by means of a simplified inheritance procedure."

In Article 135 it is stated that the Constitution can be amended only on the initiative of two-thirds of the members present and voting in the Federal Congress, and after such initiative has been approved by a majority of the State legislatures.

Such is the gist of this astounding document which puts in permanent legal form the theories and practices of the Carrancista military satraps since 1913. It is the product of the typical native politician who, while physically in contact with some of the wonders of modern times, is mentally groping in medievalism. Shades of Proudhon and Michael Bakunin! What a carnival of confiscation and of subjugation to the working class!

JOHANNESBURG, TRANSVAAL

Details of a Large Mining Transaction.

One of the most important mining deals ever consummated in South Africa has just been announced on the Rand. Solly Joel, head of the Barnato house, has acquired the interest of Sir J. B. Robinson in the Langlaagte and Randfontein mines and estates on behalf of the Barnato group, represented by the Johannesburg Consolidated Investment Co. Robinson's interest in these important properties was such as to secure his control in their management and policy, but the amount paid for this has not been made public. It is placed at between £1,000,000 and £3,000,000. The only other deal approaching this in importance was that of De Beers in 1888,

when £3,246,000 was paid to acquire the diamond claims at Kimberley. The effect of the new transaction will be to place the Barnato group in the front rank of Rand mining houses, and as this firm is interested in important adjoining properties on the West Rand, it is expected that the ultimate effect will be to rehabilitate that part of the Rand in the good opinion of investors, as undoubtedly for some time past West Rand prospects have been on the down grade. The change in control will also do something towards benefiting the whole Rand, because Sir Joseph Robinson has always preferred to play a lone hand in labor and mining, and sometimes in direct opposition to the rest of the Rand. It is, however, expected that the new control will, as previously, fall in line with the Chamber of Mines, and thus ensure a united mining policy for the whole of the Rand. At Langlaagte and Randfontein the change of control will also be generally welcomed, as the policy pursued by Sir Joseph Robinson has never been apparently fixed or consistent, with the result that everything has been unsettled and changes in management throughout the mining staff far too frequent.

The importance of the acquisition of the control of these properties will be gathered from the fact that the capital of the Randfontein Estates Co. is £3,000,000, while it has a debenture issue of £2,000,000. Its holdings in subsidiary Randfontein mining companies are valued at nearly £5,000,000. The estate comprises 31,726 acres. The mining section of the concern is represented by the Randfontein Central Gold Mining Co., with an issued capital of £4,343,700, and debentures amounting to £2,734,900. The tonnage crushed monthly varies from 180,000 to 200,000, yielding gold worth £250,000 and a working profit of £80,000. During last year when the Crown Mines was experimenting with selective mining the Randfontein Central always occupied the first position in the list of gold producers on the Rand, and can always be depended on to run the Crown Mines close in this respect. Only two small dividends have, however, been paid.

The Langlaagte Estate Gold Mining Co. has an issued capital of £886,500, and is one of the pioneers of gold mining on the Rand. The farm was acquired originally in 1886 by Robinson for £6000. Milling operations commenced about two years later, so far over £2,000,000 has been paid in dividends. On the same farm is situated the Langlaagte Consolidated Mines belonging to the Barnato group, and perhaps a consolidation scheme will result from the change of control. It is also possible that some scheme of amalgamation may arise at Randfontein, whereby the Randfontein Deep property, now under the Barnato control, will be effected.

This change of control of the Langlaagte and Randfontein properties is popular on the Rand, where it is hoped that something at least will be done with the Randfontein mines to place them in a satisfactory position among the dividend-payers of the Witwatersrand.

SUTTER CREEK, CALIFORNIA

PROGRESS AT THE NORTH STAR.—ANTIMONY DISCOVERY.

The work of unwatering the North Star shaft of the South Keystone Consolidated Mining Co. has progressed to the 600-ft. level, which is now being drained. Nearly all the work done on the North Star claim during former operations was done on the 600-ft. level; a little development work was done on the 1000-ft. level, and some at 800 ft., so this shaft will soon be clear of water to the bottom, after which the drifts on the 600 will be continued to prospect the several claims of this group, which includes the South Keystone, McIntire, Boyson, and North Star claims, much of which is unexplored territory rich in promise, as surface indications are ideal for a great mine. The intention is to unwater the shaft to the bottom before attempting other work. The North Star is nearly vertical and about 1000 ft. deep, and well situated for quickly proving all of the claims included in the consolidation.

There is known to be a shoot of valuable ore in the South Keystone mine, which joins the Keystone on the South, and it is thought that some of the ore of this shoot may have been mined through workings of the South Spring Hill mine, which lies east of the South Keystone. There are also known to be three veins outcropping in the latter claim, but no development has been done on either of them. On the McIntire claim, which joins the South Keystone on the south, there are two shafts each about 200 ft. deep. In the North Star the shaft timbers have so far been found in good condition, only occasional new sets and the laying of a new skip-track being necessary. Charles H. Colpe, general manager, of the South Keystone Con. Mining Co. was at Sutter Creek this week.

A large deposit of antimony ore has been discovered on Esperanza creek, near Mokelumne Hill, in Calaveras county, by a geologist in the employ of the Federal government. The hills in that vicinity are being scoured by prospectors in search of other deposits.

Contrary to expectations, the new motor for the Old Eureka mine, on which the operation of the new hoisting plant depends, has not yet arrived, and as the plant thus far has nearly reached the limit of its capacity the electrical machinery is anxiously awaited.

JOPLIN, MISSOURI

ORE PRODUCTION HAMPERED.—NEW MILLS.—OKLAHOMA.—TAXES.—COAL-BURNING INSTALLATIONS REPLACE NATURAL GAS.

Cold weather, shortage of water, and a continued lack of sufficient electric power for the motor-equipped plants, have helped to curtail production in the Joplin district during the opening weeks of 1917. Though the output is greater by probably 2000 tons per week than the average maintained before the War, it has been below possibilities by at least a similar quantity. The cold weather has increased the water shortage. Last summer was unusually dry; there was a fairly wet fall followed by a dry winter, so far. Many plants have been working carefully with water for concentration, but when ponds freeze solidly and keep water from flowing back to ponds from tailing-piles numerous plants had to close and wait for warmer weather. The power shortage has been a bother since last summer. If there had been any considerable rainfall, the White River plant of the Empire District Electric Co. would have been able to supply enough to take an overload off the steam-driven turbines at Riverton, Kansas. As it was, these turbines were overloaded, and have, all three of them, broken under the strain. One is hardly repaired when another is out of commission. The company hopes to have repairs completed by March, so that all motor-driven plants can be operated full time.

It was natural that considering the power troubles, and with a doubtful quantity of natural gas available, most new plants are installing coal-fired boilers for power. A number of electrically-driven plants also have changed over to coal, though the coal situation has been doubtful enough to retard such a movement. The largest steam power-plant in the district is being installed by the Oronogo Mutual Mining Co., at Oronogo. It includes one 400 and one 350-hp. boiler, an Allis-Chalmers cross-compound Corliss condensing engine, and a 2600-ft. cross-compound Corliss compressor. The plant complete is to cost $70,000. At the time it was purchased, the compressor mentioned was the largest in the district. Since it was bought, however, the Chapman-Hosley company, which has taken over the Schoolhouse mine at Carterville, has purchased and is installing one of similar size. Other important additions and enlargements are being made by this concern at this property, which formerly was operated by J. F. Dexter. Its new capacity will be 700 tons in 20 hours. Water-hammer drills have been installed and the mine, which formerly was dusty, is now entirely sanitary. One interesting feature is a 37-hp. oil-engine installed underground for operating a geared

pump. It is the first time such an engine has been used in the district for this purpose.

The Blue Mound Mining Co. has commenced to operate a new concentrating plant in Kansas, just across the State line north from Picher, Oklahoma. The mill cost $125,000. This may be considered a fair illustration tending to show both the increased cost of mill-building and equipment in this field, and also the tendency toward more elaborate plants. Before the War started, a plant that cost $75,000 here was the exception; now there are a number, and others that have cost nearly twice this amount. The Blue Mound plant, while modern and of approximately 300-ton per shift capacity, with a sludge department that will house, eventually, 18 tables, does not compare with the Netta plant of the Picher company, at Picher, nor the No. 3 mill of the Coahuila Mining Co., erected during the past six months at Duenweg. Recently the Netta mill established a new record for the district. In 20 hours continuous operation it made 107 tons of zinc concentrate and 6 tons of lead, treating 1400 tons of ore. This leases in this region, and recently let a contract for 18,000 ft. of drilling. The organization of business men from Columbus, Kansas, who started prospect work near their town, has received no encouragement so far, as out of four holes put down no ore has been found.

Oklahomans are annoyed over a measure introduced in their State Legislature, proposing a 2% tax on the production of all ores. It is estimated that such a tax would mean an assessment on the Oklahoma portion of the zinc and lead region of at least $200,000 per annum. Missouri mine-owners are also to be taxed by a bill introduced at Jefferson City, which would impose a tax of 4 cents per ton on zinc-blende and lead concentrates and of 1/20 cent on silicate. It is probable some such tax will be levied, as the State must raise more revenue. Mining men are not protesting much.

The Oklahoma districts are monopolizing attention in development, and they deserve such. During the winter there have been few important strikes in the older centres. Northeast of Lawton, Kansas, near Waco, Missouri, there is much

THE RED BIRD ZINC-MILL AT CARTERVILLE, NEAR JOPLIN, MISSOURI.

also shows the value of the ground. The Netta is the largest of the four mills erected by the Picher company last summer, and is operated throughout by electricity.

From the standpoint of development interest continues in the Oklahoma portion of the region, with indications that the rich run of ore extends well into Kansas, in the neighborhood of Baxter Springs. Scores of drills are operating in the area between Baxter and Commerce, Oklahoma, and a large number of strikes are reported, most of them unusually rich. As proof that this phrase of "unusual richness" is not boomtalk, it may be noted that an assayer's report on a recent hole put down on the Hartley farm, a short distance south of Baxter, showed 20.5% blende from 195 to 200 ft.; 31.8% blende at 205 ft.; 39.95% at 210 ft.; 43.05% at 212 ft.; 17.07% at 215 ft.; 32.1% at 217 ft.; and 4.80% at 218 ft. A still better hole than this, however, is reported by the Walker Mining Co., wherein the drill encountered ore at 170 ft., and for 23 ft. the average assay was slightly higher than 45%, while for the succeeding 47 ft. it was in excess of 20% blende.

Numerous new companies are being formed to prospect or develop in the Oklahoma field. Among the largest of the more recent organizations is the Tri-State Mining Co., which has been incorporated under the laws of Oklahoma for $500,000. L. C. Church, of Joplin, who is one of the pioneers in the Oklahoma field, is largely interested in this company. Mr. Church and E. C. Mabon of Miami have recenty acquired first lease on 1000 acres of land in Kansas, three miles north of Baxter, and will do extensive drilling. Gatch and Burns, formerly interested in the Granby company before its sale to the American Zinc, Lead & Smelting Co., have acquired large activity in drilling, and some rich ore has been found. Near Diamond, Missouri, R. L. McGee has completed a new silicate mill on new territory. At Neck City the Missouri Zinc Mines Co. has installed a Pomona pump to drain the old Texmo shaft, which it expects to operate along with the Quick Seven. At Joplin, Mattes Brothers have taken over the Symmes and Dick Turpin mines south-west of the city, and will operate both.

The new Red Bird mill outputs 60 tons of blende and 60 tons of galena concentrate monthly when working but one shift per day. This plant was described in our issue of December 23, 1916.

In spite of the railroad embargo upon freight shipments, there has been little lessened activity in the zinc and lead-ore market for the past week. Prices for 60% zinc ranged from $70 to $90, at which figures the ore buyers apparently are willing to take all of the ores they can secure, taking their chances of securing cars for shipment. There is an almost feverish activity in the buying of lead ores, at prices ranging from $105 to $110 per ton for 80% lead. There is a greater tendency between the ore buyers and the ore producers to get together on this market. The great preponderence of zinc production over lead makes it feasible to hold zinc ores rather than lead ores when the market shows signs of further advance. With lead selling at such high figures, even the small proportion of this product to zinc is sufficient in some instances to carry the burden of the pay-rolls from week to week and allows the ore producer the privilege of selecting his own week for the sale of his zinc ores at such times as he feels the market situation to be in his favor.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

(Special Correspondence.)—The Goodro mine is installing a 50-ton flotation-plant. The machinery is on the property and a pipe-line and dam for power is completed.——The It mine has 5000 tons of 3% copper ore broken in the stopes and 10,000 tons blocked out.——The Harper syndicate, operating the Westlake mine, is installing a concentrating-plant to handle the low-grade ore containing gold, silver, lead, zinc, and copper. Arrangements have been made to ship the high-grade ore to Butte, Montana.

Ketchikan, February 10.

The discovery of a new placer field in the Tanana valley, 125 miles from Nenana, in what is known as the Tolkat country, which joins the Kantishna district, is reported. Few people are there at present and the district is hard to reach. Fred Houselman is said to have taken $1000 in gold out during the late fall on Moose creek. The shaft sunk by Houselman is 22 ft. deep, but did not find bedrock, according to the report. A shaft sunk by Gleason and Grant was put down 12 ft., but produced a few coarse colors. They had intended to 'freeze' the hole down through the thawed ground that underlies the surface and which prevents the sinking of shafts to bedrock by ordinary means, but their grub ran out and they had to come in for an outfit.

According to statement of H. P. Warren, of the Alaska Engineering Commission, at Seattle recently, 6500 men will be employed on the railway in the coming season, an increase of 1000. Nearly 60,000 applications are on file for work. From present indications, the railroad's line to Chickaloon in the Matanuska coal-fields will be completed by August 1. All station work on the 14 miles from King's river to Chickaloon was let this winter ahead of time, and the work is being rushed to completion. Plans for the coming season include the construction of all bridges in the Seward division, so that by next fall the old railroad between Seward and mile 71 will be ready for heavy traffic. Preliminary work is under way for the $300,000 railroad bridge across the Susitna river, at the mouth of Indian creek.

ARIZONA

The finding of rich ore in the Homestead mine, near Walker, has resulted in the determination to sink the shaft to 200 ft. depth. The strike was made 60 ft. from the surface, and has been followed 100 ft. in a drift.

Within the next few days it is expected that the old Hackberry mine, which has been acquired by Gus S. Holmes of Salt Lake, will become one of the regular shippers in the old Hackberry district. The work being carried on there by Mr. Holmes is causing a revival of this old camp. This old property was once the richest mine in the State, producing argentite and oxidized ores. From the oxide zone alone it is said that over $3,000,000 was produced. At the No. 1, a vertical shaft, a new hoist and compressor have been installed, the mine has been unwatered and ore is being taken out. In cleaning up the mine for development work three cars of ore were taken out and are now on the dump. In the mine there are also several cars of ore ready for stoping and which was stored underground as there was no place for this ore on the dump.

A new wagon-road has been completed to the spur from the Santa Fe road, a compressor has been installed at the No. 2 shaft, ore-bins are being built, and a hoist is being installed. This shaft is down 109 ft. in the vein.

The property consists of 300 acres and extends for over a mile along the vein system. The main shaft is down 500 feet.

During January the Miami Copper Co. produced 1553 tons of concentrate having a value, f.o.b. works, of $318,628. This compared with values of $278,513 in December concentrate and $299,396 in November. Since Miami has been compelled to make monthly statement of its flotation operations its results have been as follows:

	Jan.	Dec.	Nov.	Oct.
Tons feed	124,676	121,493	120,988	102,698
Tons concentrate	1,553	1,480	1,589	1,370
Assay	%	%	%	%
Copper in feed	1.175	1.118	1.157	1.119
Copper in concentrate	43.059	41.521	41.439	40.987
Copper in tailing	0.646	0.620	0.621	0.58

These figures are the outcome of litigation against Miami brought by Minerals Separation Co. for alleged infringement of patents. Trial of the case and argument on appeal have been heard with decision of the United States Circuit Court of Appeals expected in the course of the next two months.

The plan of dissolution of the Old Dominion Co. of New Jersey calls for the exchange of shares of this company for those of the Old Dominion Co. of Maine, on the basis of two for one, or the retirement of the stock of the New Jersey company at $61.73 a share. There are three companies—the Old Dominion of New Jersey, the Old Dominion of Maine, which is a holding company and owns all but 7000 of the 162,000 shares of the New Jersey company, and the United Globe Co., all of the stock of which is owned by the Old Dominion Co. of Maine. This arrangement necessitates the payment of three corporation taxes, not to mention duplication of clerical work and records, and it will be much simpler to have the one company, the Old Dominion Copper, Mining & Smelting Co. of Maine, which will be both the operating and holding company. This is the ultimate aim of the management, and after the dissolution of the New Jersey company the United Globe company will be dissolved in a similar manner. The Old Dominion in 1916 earned net profits of $3,532,125 and paid all but about $12,000 of this to stockholders in dividends. The January production at the mines was less than that of the preceding months, but some good prices have been obtained for copper. Costs at Old Dominion and the United Globe mines are approximately 9½c. and in January probably all of 30c. a pound has been obtained for copper. This brings profits for the month up to around $600,000, or about $7,000,000 a year. It is probable that profits for 1917 will nearly reach this figure, as present production is below normal and the condition of the copper market indicates that an average price of 30c. a pound will prevail. If this proves to be so, Old Dominion will earn well over $24 per share in 1917, against a present dividend rate of $12 per share.

Deep drilling is in progress at the Miami Consolidated property, one hole being down 400 ft. several days ago, and a second hole nearly as deep.——Work is to be resumed at the Little Jessie in Chaparral district. The mine was worked successfully for several years, during the early nineties, but operations were discontinued when a heavy flood of water came in. With improved modern machinery, Superintendent W. H. Jones thinks he will have no trouble in controlling the water.

The Black Rock (Limited) Mining & Milling Co., operating

12 miles north-east of Wickenburg, is planning to spend $150,000 in the development of its property. Diamond-drilling will be done.——The Swansea smelter is to be repaired and operations resumed as a custom works. Mining supplies have recently left Parker for the Planet and Copper Zone mines that recently were acquired by the Arizona Consolidated Smelting Co. Construction work is to begin without delay. J. W. Peart is superintendent.——At the Dundee mine in Jerome district another flow of water has been struck, necessitating additional pumping machinery.——A strike of good ore is reported from the Black Diamond mine in the Walker district, south-east of Prescott, where a vein 5 ft. wide runs over $30 in gold per ton.

CALIFORNIA

(Special Correspondence.)—With the starting on Coffee creek of the Pacific Gold Dredging Co.'s new dredge, recently completed, Trinity county has entered upon a new era of alluvial-gold production. The large acreage already acquired by this company in the Carrville district, on Trinity river, and on Coffee creek will require several more boats, one of which, it is generally understood, will be constructed this year. The same company has a large acreage under bond on the east fork of Trinity river, five miles east of Carrville, also a smaller acreage at Coffee, seven miles west. The Nash deep gravel mine at the head of Coffee creek is also under consideration, if not already bonded. It extends seven miles to Salmon river, and has a large acreage.

The boat is similar in design to that operated by this company on Yuba river near Smartsville, and is built for heavy duty with an especially strong hull. It is 135 ft. long, 60 ft. beam, and 11 ft. deep. The digging capacity is 60 ft. below water-line. There are 87 buckets with a capacity of 9 cu. ft. each, with a speed of 15 buckets per minute. Each bucket, with lip, weighs 2900 lb. The lips and bottom are of manganese steel. Bucket-pins are 6¾ in. diam. and of nickel-chrome steel. The revolving screen is 37 ft. long and 7 ft. diam. The perforations in the manganese steel plates are slotted and are from ⅜ to ½ in. by 1¼ in. The upper tumbler is of nickel-chrome steel with manganese steel cushion-plates; the lower tumbler is of the round type, and of manganese steel. The upper tumbler shaft is 12 ft. 6 in. long, 18 in. diam., and of nickel steel; the lower tumbler shaft, also of nickel-steel, is 6 ft. long and 13¾ in. diam. The spuds are 65 ft. long with 4 ft. 6 in. by 2 ft. 10 in. cross-section. The digging-ladder is 118 ft. long. The gold-saving tables are of wood with two decks, and have a total area of 5000 sq. ft. The tailing-stacker is 155 ft. long and of open construction. There are eight motors, the main drive being 300 hp.; high-pressure pump 100 hp.; low-pressure pump 75 hp.; stacker 50 hp.; screen 50 hp. There are two 12-in. pumps and one 6-in. The boat is equipped with crane and car for removing and dumping large boulders. There are no transformers on the boat; all motors have a 2200 voltage. There are three water-tight compartments, one in the bow, one in the stern, and one around the well-hole. The boat was built by the Marion Steam Shovel Co., and erected by the Pacific Gold Dredging Co. Its total weight is 1600 tons. The work of erection was in charge of Oscar Wicks, foreman, and H. G. McNaught. It is operating with H. C. McNaught as superintendent and C. O. Kister as dredge-master.

Carrville, February 20.

(Special Correspondence.)—The Plymouth Consolidated Gold Mines (Ltd.) has issued the following statement of the production and expenses at that property during the month of January:

Tons milled	11,000
Value	$61,750.00
Work expense	30,077.00
Development	9,695.00
Surplus	21,978.00
Other capital	444.00

Plymouth, February 21.

CHEROKEE. Forty men are engaged in prospecting at this place in Nevada county. The Hammon Construction Co.'s drills have found bedrock at 240 and 310 ft. depth. The gravel is tested every two feet in depth.

That the mining operations in Nevada county were never on a better footing, says the *Grass Valley Union*, is evinced by the fact of the large number of smaller mines that are being re-opened. The Signal Mining Co., headed by E. M. Taylor, which operates a mine two miles west of Grass Valley has completed installation of a new Cornish pumping-plant, and the water is now drained. Work of deepening the shaft will be commenced.

The Sunset Mining Co. has shipped 2130 lb. of tungsten concentrate that went better than 70% by gravity test, says the *Randsburg Miner*. The lot was purchased by Wigmore & Co. of Los Angeles for Eastern consumers. The shipment represents the residue of five tons of ore taken six miles west of Randsburg from the Evening Sun group of eight claims in the new district below Powell's camp, and is an improvement on a previous shipment made a year ago. The new shaft is down 50 ft. almost vertical, and driving has progressed fully 60 ft. There is now three inches of 40% ore in the bottom of the shaft with numerous little high-grade stringers.

The following individuals and companies have made application to the California State Water Commission for permission to appropriate water for mining purposes:

The La Grange Mining Co., of Weaverville, 10 cu. ft. per second of the waters of Salt creek tributary to Stuart's fork in Trinity county for hydraulic mining.

Charles E. Knox of Berkeley, 20 miner's inches of the waters of Willow and Alkali springs in Inyo county, for use at a quartz mine. By a pipe-line eight miles long it is proposed to carry the water to the mine in the Ubehebe mining district at a cost of $2000.

Henry O. Bradley of Hornbrook, one cubic foot per second of the waters of Rancheria creek, tributary to Cottonwood creek in Siskiyou county for mining and milling purposes. A pipe-line 500 ft. long will conduct the water to the mine from point of diversion and the water is to be returned to the river after use. The estimated cost is $6000.

Charles L. Austin of Wilbur Springs, 20 miner's inches of the waters of un-named springs tributary to Sulphur springs in Colusa county for milling purposes at a gold-quartz mine. It is proposed to carry the water to the mine by pipe-line 2½ miles long, the estimated cost to be $6000.

The United States Smelting, Refining & Mining Exploration Co. of San Francisco, 30 cu. ft. per second of the waters of Red Clover creek tributary to Indian creek in Plumas county, for power purposes. It is proposed to utilize a fall of 1300 ft. and to develop 4300 theoretical horse-power. The applicant has been given until July 1 to file maps and other data necessary to a consideration of the application.

Superintendent Taylor of the Butte mine at Randsburg will put on an additional force. The ore is in sight; the mill can handle it nicely, and the plan is to get it out as fast as possible. The new mill is working well and the water supply obtainable is said to be ample. This new enterprise is only one of many contemplated, and with the influx of many new miners an era of renewed prosperity is assured for this district.

Elden Low was killed in the Pyramid mine in El Dorado county February 20, by being overcome by gas at the bottom of the shaft. His companion, Fred Turuboo, managed to climb the ladder to the 500-ft. level and escaped a similar fate.

CALISTOGA. An unusual development has taken place at the Socrates quicksilver mine near Calistoga. Throughout this mine the mercury occurs mainly in metallic state, though there are also stringers, veins, and bunches of cinnabar, some of it running as high as 60% quicksilver. Recently two faces of ore have been exposed on one level, at a depth of 300 ft., where the vein is 12 ft. wide, running 35%, mostly metallic

mercury. Scattered through the mass is considerable cinnabar. These two exposures are 500 ft. apart. A new 50-ton Scott furnace has been built, which is now in process of drying out. It will require about two weeks longer to get the furnace in proper condition to begin distillation of the ore. It is thought, however, that the Scott furnace may not be well adapted to this class and grade of ore, it being intended for low-grade ores containing cinnabar. The idea of putting in retorts to treat the high-grade material is being seriously considered. Another difficulty that confronted the management was the fact that the miners became badly salivated in the mines. An investigation led to the belief that this was largely, if not wholly, due to the fact that the miners made a practice of smoking while on shift. Smoking was prohibited and since then salivation has practically ceased. There is also a mining problem to be solved; that is to prevent the almost inevitable loss due to the presence of so large an amount of native mercury in the ore, much of which falls out on the floor of the drift when the ore is blasted. This difficulty will probably be overcome by covering the floor with canvas at the working places, and protecting the canvas by placing planks over it.

An ample supply of water for continuous use in mining now appears assured in northern California. There was six feet of snow on the level at Truckee on February 22, and it has continued to snow almost constantly ever since, so the outlook for an abundant water supply during the year is good.

The Eagle-Shawmut mine on the Mother Lode, three miles east of Chinese, in Tuolumne county, has been bought by the Tonopah-Belmont Mining Co. The mine has been operated since 1893 by John Rosenfeld's Sons, of San Francisco, and is one of the large and deep gold mines of California. It is worked through a shaft 2300 ft. deep and is equipped with a 100-stamp mill, chlorination plant, and other necessary accessories of modern gold mining.

Louis Japoni, a miner, was drowned in the shaft of the Rawhide mine, in Tuolumne county, on February 22. He apparently was overcome by gas and fell into the sump.

COLORADO

(Special Correspondence.)—The yearly report of the Portland Gold Mining Co. shows a net profit of $768,809.84. Dividends paid during 1916 amounted to $420,000. Total production to date from this property amounts to 2,814,043 tons of ore of a gross value of $43,844,865.41. The total amount of dividends paid to date is $10,597,080. The heading of the Roosevelt drainage tunnel is now within 1600 ft. of the west side-line of the Portland property. The tunnel will cross the Portland property at an elevation of 8112 ft. above sea-level, or 164 ft. below the bottom of No. 2 shaft, and below the 19th level.

Victor, February 20.

IDAHO

A snowslide at the North Star mine, 12 miles north-east of Hailey, in Wood River district, on Sunday resulted in the death of 15 men and the injury of others. The slide destroyed the bunk-house, compressor, and warehouse. Ninety men were at work in an attempt to rescue the men buried in the snow, but the work was ordered stopped, as there was great danger of a second slide, which, should it occur, would engulf the entire rescuing force. The mine is operated by the Federal Mining & Smelting Company.

(Special Correspondence.)—BANKS. The Alpine silver mine near here is being developed by John A. Percival of the Interstate-Callahan Co., under the direction of Frank E. Johnesse.

BRUNZELL. The Sunnyside mine is being operated by John M. and H. W. Baker, formerly of the Baker Mines Co., of Cornucopia, Oregon, and a 30-ton ball-mill is being added to the equipment.

BURGDORF. The Mount Marshall tunnel has cut the vein on the Mt. Marshall group at a depth of 1500 ft., and it is reported that gold ore running from $40 to $50 has been found.——The Sherman-Old Corporal mine has been purchased by L. T. Holte, an Alaskan miner, and a 30-ton mill erected. Since October 24 this mine is reported to have turned out about $100,000. The high-grade ore carries silver-gold, tellurium, besides the metallic gold.

ELK CITY. Seattle parties have bonded the Gilt Edge and Coeur d'Alene groups in the Ten Mile district. There is considerable ore developed in both of these properties.——The Homestake mine, owned by James Pneman, has been bonded to Sacramento people for $30,000. This property was the first discovery, in 1896, in the old Badger camp, and has been extensively developed by adits run on the vein.

IDAHO CITY. The Lucky Boy mine, in the Gambrinus district, is installing a 100-hp. Diesel engine and electric generator. This power will be used to operate the mine and milling-plants. A Marathon mill is also being installed.

MOUNTAIN HOME. The Reber mine, near Pine, is being unwatered by a syndicate of San Francisco capitalists, headed by M. L. Requa. The shaft is 400 ft. deep and there are about 3500 ft. of levels to be drained. This property has been idle for many years.

MULLAN. During the fourth quarter of 1916 the Consolidated Interstate-Callahan company made a profit of $747,131. There was shipped to smelter 3476 tons of 48.1% zinc ore, 297 tons of 16.7% lead ore, 13,676 tons of 45.65% zinc concentrate, and 1111 tons of 23.3% lead concentrate. The total was 18,560 tons, containing 16,424,704 lb. of zinc and 1,286,670 lb. of lead. The net value on cars was $999,025. Costs totaled $6.065 per ton. The mill treated 33,726 tons averaging 24.75% zinc, 2.1 oz. silver, and 6% lead. The recovery was 81%. Dividends amounted to $697,485.

NAMPA. The Sinker tunnel at 6700 ft. from the portal has cut the Golden Chariot vein, at a depth of 2400 ft., and 700 ft. below the old deepest workings on this famous property on War Eagle mountain. These old mines have been idle and filled with water since 1878.

The Oro Grande Gold Mining Co. at Sites, is to equip a new mill having two tube-mills, and a cyanide plant. The old machinery is to be overhauled and remodeled as far as necessary.

MICHIGAN

The stockholders of the Tamarack Mining Co. are to hold a meeting March 16, to vote on the question of selling the Tamarack property to the Calumet & Hecla.

HOUGHTON. The coal shortage promises to become more serious, and the larger companies are arranging to get fuel by rail. The Calumet & Hecla contemplates erecting coal-handling equipment on Torch lake similar to that at Duluth and other Lake points. Bad weather curtailed copper production during February.

During 1916 the Copper Range company's net profit was $6,078,189, a gain of $2,514,427 compared with that of 1915.

MONTANA

BUTTE. Zinc-lead-silver ore is being shipped by the Butte & Great Falls company's Neihart mine to the Washoe reduction works. Underground conditions are good.

KENDALL. The Barnes-King Development Co. has issued its report for 1916, including the remarks of the manager G. T. McGee. Net earnings from the mines were $139,671, less $43,332 for losses at the Piegan-Gloster, rents, etc., leaving $96,338 net. Dividends paid totaled $60,000. On December 31, 1916, bullion, cash, etc., amounted to $109,783, while liabilities included notes payable $75,000. The 1916 profit was $51,630 less than in 1915, due to a decrease in tonnage and gold from the North Moccasin and a larger loss from the Piegan-

Gloster. The latter is now yielding better ore. Option payments on the Shannon, aerial tram, crusher, and $100,000 payments for the Kendall drew heavily on the treasury, so $90,000 was borrowed. Of this $15,000 has been repaid.

The North Moccasin mine yielded 33,715 tons of $8.65 ore. The recovery was 86.5%. The Kendall lease produced 14,918 tons averaging $2.50 per ton. The Piegan-Gloster mill was remodeled, and is now treating 174 tons daily with 95% extraction of the gold and 68% of the silver. During the year it treated 35,536 tons of $9.48 ore, at a cost of $1.465 per ton. The tram from the Shannon mine to the Gloster mill was constructed at a cost of $25,600. Cost of mining, development, and crushing at the Shannon is $2.53 per ton.

The Woodrow Wilson mine in the Rimini district is under option to the Barnes-King for $120,000. Prospects are good.

Bailing continues at the shaft of the Colusa-Leonard Extension Co. and within 10 days sinking from the 800 to the 1600-ft. level will begin. The water has been lowered to below the 600 by tanks and in addition to this method of unwatering, pumps shortly will be in commission which will expedite the work. This work is under the direction of the Tuolumne Copper company which has a development contract with the Colusa-Leonard Extension company for the sinking of the shaft and the cross-cutting on the 1600-ft. level to the north and south side-lines of the group of claims embraced in the holdings of the Syndicate Copper company. For this development the Tuolumne company will receive 51% of the Syndicate stock, the balance being owned by the Colusa-Leonard company. In addition the Tuolumne company has 265,000 shares of Colusa-Leonard stock. It is probable that an agreement will be reached between the Tuolumne and the Colusa-Leonard companies whereby driving operations west on the 700-ft. level of the Spread Delight vein may be continued into the Colusa-Leonard. The west breast of the drift is a short distance from the east end of the Colusa-Leonard group and there is little doubt that the ore continues into the Colusa-Leonard territory. It is expected that another arrangement will be reached for cross-cutting the Spread Delight vein on the 500 and the 800-ft. levels of the Colusa-Leonard and another fissure lying close to the shaft, which in the Main Range property adjoining, shows a shoot of ore ranging in width from two to three feet of high-grade ore. The Tuolumne, in February, shipped 1000 tons of ore from the Sinbad shaft as compared with 700 tons in January, despite the fact of February being a short month. From the Tuolumne shaft the tonnage for February was expected to approximate 4000 tons.

The Furnace Creek Oxide Copper Co., that ten years ago was organized to operate mines in the Death Valley region of California, and failed to find anything of value in the claims explored by the company, has now acquired by lease and option the Eclipse-Argo mines, comprising a group of five claims at Hell-gate canyon, 30 miles east of Helena. The purchase price is stated to be $225,000, of which $50,000 was paid in cash January 15. The balance is to be paid in five installments of $35,000 each, at intervals of four months after the first payment. A crew of miners has been employed on development work, and for some time the present owners have shipped five cars of ore monthly to the Washoe Reduction Works, at Anaconda, for which they received from $3000 to $3500 per car. Since July 1, 1916, the mine has produced a total of 1052 cars of ore for which the smelter paid $114,071.

NEVADA

ROCHESTER. To develop an orebody in its Shepherd No. 1 adit the Rochester Combined Mines Co. is driving a lower adit. During May a 300-ton plant is to be commenced, to be ready early in November. Cash on hand is $80,000.

Lane and Ishway, working claims north of Groom camp, near Pioche, have found a vein that assays $14 gold. The shaft of the Groom North Extension company, situated north of the Groom mine, is down 40 ft. It is intended to cut the main lode on the dip. After driving 50 ft. the company will install a gasoline-hoist.

The caterpillar train and trucks are moving again and ore is going steadily from the Groom mine to market. The snow melted slowly and no time was lost through muddy roads. The distance to Indian Springs station is 60 miles, and the Packard and Sauer trucks have been able to make a round trip (120 miles) in 24 hours, on several consecutive trips during the past ten days.

The old Highland Mary mine at Austin is to be operated by Frank McLaughlin and George Gordon, who have a lease on the property from the owner, the Nevada Equity Mines Co.

Another attempt is to be made to re-work the large tailing-pile from the Comstock mills, four miles from Dayton. The tailing covers several acres of ground to the depth of 2 to 12 ft. and assays 3 to 4 oz. silver and a little gold. It also contains sodium chloride, copper sulphate, mercuric chloride, and quicksilver, but it is now believed that the metallurgical treatment has been solved successfully, though former attempts failed. A plant having a capacity of 150 tons daily is to be built by the Placer Recovery Co.

The hoisting-plant, change-house, and blacksmith-shop at the Great Western mine, two miles west of Tonopah, were destroyed by fire on February 20. The fire was attributed to an overheated stove in the change-house.

Water has been lowered to the 2900-ft. level of the Union Consolidated mine, on the Comstock. Work is being pressed with vigor on several of the north-end mines, in fact, work along the entire Lode is being stimulated by the recent rise in the value of silver.

Goldfield desires to secure a school of mines, such as is maintained by the State at Virginia City and Tonopah. A bill to secure such a school was introduced in the Senate February 20 by Senator Elliott. The measure provides for paying a principal $2400 yearly and authorizes $3000 expenses in maintaining the school.

It is reported at Tonopah that the old lead-silver mine at Tybo, in central Nye county, is to be re-opened. Walter Trent of Reno, president of the Trent Engineering company, has for the past six months been perfecting arrangements for operating the principal group of mines, which have been favorably reported upon by competent engineers. Barney Baruch, of New York, is said also to be interested and with him are associated other prominent and wealthy New York mine investors under the name of the Louisiana Consolidated Mining Company.

The MacNamara Mining company at Tonopah has resumed work on the 300-ft. level, through the West End workings, at a different part of the property than that where the work lower down is being done, the two working-places being about 1000 ft. apart. Some ore was exposed on the upper level near the West End line, and arrangements have been made to mine this in an economical manner through the West End workings. Shipments, therefore, are coming from two places in the mine at the present time.

NEW MEXICO

The Burro Mountain Copper company, after experimenting with a small leaching-plant at Tyrone the past three years, has found that method to be successful in treating the low-grade copper ores. During the latter part of 1916, the company constructed a modern leaching-plant at a cost of $85,000, which has been operating satisfactorily. The present leaching-plant is to be greatly enlarged. Plans have been agreed on and work will go forward without delay.

(Special Correspondence.)—The Granite Peak Copper Co., of Granite Peak, Grant county, New Mexico, that was recently organized, will install machinery at its mine.——The Copper Queen Mining Co., of Bisbee, Arizona, plans to build a concentrating-mill of daily capacity of 3000 tons. It will also install steam-shovels to remove the overburden of Sacramento

hill.——The Nacozari Consolidated Copper Co., of Nacozari, a subsidiary of the Copper Queen, operating at Sonora, Mexico, is about to install the flotation system in its mill, and the Montezuma Copper Co. will equip its concentrator with new tables and slimers at Nacozari.——The Greater Miami Copper Co. will build a mill on Mineral creek, near Globe.

Douglas, Arizona, February 22.

The Mogollon Mines company cleaned up approximately 16,000 oz. gold and silver for the first half of February. Driving on the 900-ft. level is now advancing at the rate of 9 ft. per day, in a single heading. This is the fastest work ever done in the district. Leyner drills are used and both drilling and tramming is contracted.

Elmer James, operating the Trilby property, has opened a face of ore on the lower-tunnel level. This vein is the extension of the S. Johnson which is being advanced in ore on the lower level toward Trilby ground.

Socorro Mining & Milling company shipped sixteen 100-lb. bars of bullion for the first 15 days of February. The mill is handling better than 200 tons per day.

Considerable prospecting is being done south of White Water. Some good assays are coming in and a number of claims have been located.

Preparation are being made to resume work on the Meerschaum mines, 40 miles north of Silver City. These are the only depesits of meerschaum known in North America. Operations will be under the direction of J. P. Porteus.

UTAH

Goodwin, formerly Gold Hill. According to the Salt Lake *Mining Review* the Deep Creek district, Tooele county, into which a railway is being constructed, has a promising future. Although minerals were discovered 60 years ago, lack of transportation facilities discouraged everybody. The elevation is 4500 ft. upward. Surface mineralization is good. Ore is not confined to fissures, but occurs in the lime-porphyry contact also. The Western Utah Copper Co. has the largest property, after which come the Calaveras, Pole Star, M. R. Evans, Queen of Sheba, Garrison Monster, and others.

Fifty Greek pick-miners were paid off at the Standardville coal mines February 20, when they demanded an increase of wages on threat of striking. The increase was refused by the company on the ground that a 10% raise had been accepted three months ago with an agreement that no further increase would be asked within at least a year from that time. "Three months ago we granted an increase of 10% to the pick-miners without advancing the pay to the inside men and machinists," said F. A. Sweet, president of the company to the *Deseret News*." This increase placed our pick-miners considerably in advance of those of other mines, some of them making as much as $11.50 per day, and the poorest making $6.50. Of course they did not work every day, but during January some of them earned $228, others ranging below that figure. Our increase was given on the men signing agreements not to ask additional raises within a year.

"The demand for an increase again within three months of that agreement was occasioned by the recent increase of the Utah Fuel company. This company after the increase was paying its pick-miners only as much in some instances as we were already paying, while at the Clear Creek mine the rate still is five cents a ton under our rate.

"This new demand on the part of our pick-miners was apparently the first step in a movement to make the companies concede another blanket increase. There is no other class of laborers in the country making such wages as our pick-miners now, and we felt perfectly justified in declining the demand. We look for our action to settle the matter in a short time."

Robert R. Scott, a pioneer miner of Amador county, California, died February 23, aged 78 years. For many years he was a hoisting engineer at the Kennedy mine.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

R. A. Kinzie is at Phoenix, Arizona.

Charles Janin is on his way to Siberia.

W. DeL. Benedict is at the Palace Hotel.

J. Nelson Nevius has been inspecting mines in Mojave county, Arizona.

Nelson Dickerman has gone to Guatemala, expecting to return early in May.

Samuel W. Cohen has his office now in the Dominion Express building at Montreal.

R. S. Wickett has succeeded A. M. Hay as president of the Trethewey Silver Mines Co. at Cobalt, Ontario.

Thomas H. Leggett was at Los Angeles lately, on the occasion of a mine examination in southern Nevada.

A. B. W. Hodges has returned to Los Angeles after visiting old friends in British Columbia, as far north as Anyox.

Edgar A. Collins has been appointed manager of the Ridder mine, in the Altai, Siberia, and will proceed thither in April.

William F. Duthie succeeds Alexander Burrell, deceased, as manager of the Argo mine, of the Furnace Creek Oxide Copper Co., near Helena, Montana.

Thomas N. Miller has been appointed general manager for the Blair Cambria Coal Co. and the Altoona Northern Railroad Co., with headquarters at Altoona, Pennsylvania.

Fred. G. Farish has resigned as manager of the Lluvia de Oro Gold Mining Co. and has taken the management of the Mineral Hill Consolidated Copper Co., Tucson, Arizona.

J. W. Warford, for four years past assistant manager for the Original M. & M. Co., at Clearinghouse, has resigned his position. He will sojourn for a brief period at Alameda, California.

Clyde T. Griswold is examining oil-lands in Oklahoma; F. G. Clapp is in Wyoming; M. L. Fuller is touring the South; Ernest Marquardt is studying the southern and central fields of Oklahoma; and E. B. Hopkins is in Mexico.

Alexander Burrell died suddenly at the Argo mine, near Helena, Montana, on February 13. He was born at Edinburgh, Scotland, in 1851, and came to Chicago in 1856. He first engaged in mining in Illinois, operating a coal property. In 1888 he moved to Marysville, Montana, and entered the service of the Montana Mining Co., which worked the famous Drumlummon mine. In due course he was promoted to general manager and continued in charge until 1913, when the company ceased to operate. In the early part of this year he was appointed manager for the Furnace Creek Oxide Copper Co., operating the Argo mine, near Helena, Montana. He was a capable engineer, a man of high character, and a good citizen.

The annual general meeting of the Faraday Society was held at London, December 18. Sir Robert Hadfield was elected president. The report of the council states that in spite of difficulties consequent on the War, it was found possible to hold two general discussions in the year under review, one on 'The Transformation of Pure Iron' and the other on 'The Corrosion of Metals: Ferrous and Non-Ferrous.' The symposium on corrosion has been characterized in an American journal as the most valuable collection of papers that has yet appeared on this subject in England. The report indicated that the Society had been able to be of some service to the Government in connection with the War, and it states that besides those of its members who are on active service, a considerable number of the officers and members are serving on the various Government boards and panels that have been constituted since the beginning of the War by the Admiralty, Ministry of Munitions, and Board of Education.

THE METAL MARKET

METAL PRICES

San Francisco, February 27.

Antimony, cents per pound	24
Electrolytic copper, cents per pound	36
Pig lead, cents per pound	9.50—10.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$135
Spelter, cents per pound	12
Tin, cents per pound	47.50
Zinc-dust, cents per pound	18—20

ORE PRICES

San Francisco, February 27.

Antimony, 50% metal, per unit	$2.00
Chrome, 40% and over, f.o.b. cars California, per ton	18.00—20.00
Magnesite, crude, per ton	8.00—10.00
Tungsten, 60% WO_3 per unit	17.50—18.00
Manganese, 50% (under 35% metal not desired)	29.00

Manganese ore, 40 to 45%, sells f.o.b. Chicago at 58c. per unit with a penalty of 50c. per unit for more than 8% silica.

New York, February 21.

Tungsten: The uncertainty of arrivals from the West has made premium prices possible. Scheelite is in demand, and has brought $17 for immediate delivery. For ferberite $18 per unit has been realized. Wolframite has recently been sold at concessions, but $16 is declared to have been the minimum, and most of it went well above that figure. The foreign demand is good, and unless stocks are soon replenished a stronger market may be looked for.

Molybdenum: The freight congestion has interfered seriously with deliveries, and complaints are heard in many directions. The ore is scarce, and brokers decline to give a quotation. The last was $1.80 per lb. for 90% concentrate.

Antimony: This ore is held at $2.50 per unit, but no business is reported.

EASTERN METAL MARKET

(By wire from New York.)

February 27.—Copper is strong but quiet. Lead is quiet, with the railroad situation somewhat easier. Spelter is stagnant.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Feb. 21	36.00	Jan. 16	28.33
" 22 Holiday		" 23	29.34
" 23	36.00	" 30	31.91
" 24	36.00	Feb. 6	33.00
" 25 Sunday		" 13	33.90
" 26	36.00	" 20	35.37
" 27	36.00	" 27	36.00

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	....	Aug.	17.27	27.03	....
Mch.	14.80	26.65	....	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

The Lake Superior mines during January produced the following amounts of copper in pounds: Ahmeek, 2,411,329; Allouez, 861,413; C. & H., 6,576,868; Centennial, 163,841; Isle Royale, 1,172,149; La Salle, 130,761; Osceola, 1,513,942; Superior, 318,798; Tamarack, 585,328; White Pine, 368,697; total, 14,103,126 pounds.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Feb. 21	77.62	Jan. 16	74.66
" 22 Holiday		" 23	75.87
" 23	77.62	" 30	75.87
" 24	77.37	Feb. 6	76.79
" 25 Sunday		" 13	77.62
" 26	77.12	" 20	78.41
" 27	77.12	" 27	77.37

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	48.85	56.76	75.41	July	47.52	63.06	....
Feb.	48.45	56.74	....	Aug.	47.11	66.07	....
Mch.	50.61	57.89	....	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Feb. 21	9.50	Jan. 16	7.50
" 22 Holiday		" 23	7.72
" 23	9.50	" 30	8.02
" 24	9.50	Feb. 6	8.41
" 25 Sunday		" 13	8.60
" 26	9.50	" 20	9.58
" 27	9.25	" 27	9.45

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	....	Aug.	4.67	6.28	....
Mch.	4.04	7.26	....	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Feb. 21	10.75	Jan. 16	9.37
" 22 Holiday		" 23	10.00
" 23	10.75	" 30	10.41
" 24	10.75	Feb. 6	10.06
" 25 Sunday		" 13	10.52
" 26	10.75	" 20	10.54
" 27	10.50	" 27	10.70

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	....	Aug.	14.17	9.03	....
Mch.	8.40	18.40	....	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date.		Week ending	
Jan. 30	85.00	Feb. 13	140.00
Feb. 6	90.00	" 20	140.00
		" 27	135.00

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	....	Aug.	93.75	74.50	....
Mch.	78.00	219.00	....	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

At New York, on account of considerable quantities now coming on the market, the high price of $150 was not maintained. Some of the principal sellers are quoting $135 per flask. Regular buyers are able to get delivery of the metal below that figure.

TIN

Prices in New York, in cents per pound.

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	....	Aug.	34.57	38.88	....
Mch.	48.76	50.50	....	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Owing to the arrival of tin and sales to realize, the market has taken a downward turn, with little inclination on the part of the buyers to come into the market. On the other hand, sellers not being sure about replacing of lots sold, in view of the submarine danger, are reluctant to dispose of this holding, and spot tin is quoted at 49 to 50c., with Banca tin about 47 cents.

ANTIMONY

The New York antimony market is firm. Spot and early March delivery is hardly obtainable. Thirty cents has been paid for a quantity for delivery prior to the middle of March and spot is quoted at 32c. The needle antimony is offered at 12c. for spot and about 10c. for shipment.

PLATINUM

Price of platinum, New York, is $105 per ounce for soft metal and $111 for hard.

Eastern Metal Market

New York, February 21.

The paralysis of freight transportation has created an abnormal and most unusual condition in all the metals, especially lead, zinc, and antimony. The break-down of the railroads, with the consequent marooning of freight cars all over the country, has created a dire scarcity of stocks on the Atlantic seaboard. As a result the quotations for spot copper, lead, and antimony have soared, and buyers whose needs forced them into the market have been squeezed. Future deliveries have been almost dormant for the reason that consumers realize that prices will drop when the freight difficulties are smoothed out, and the many shipments on the way begin to arrive. With regard to spot prices it is not fair to call them the market, for not much is doing.

Prompt copper is quoted at 36c. to 37c., with the metal scarce, but in light demand.

Zinc consumers are paying but little attention to buying, meanwhile prices are firm with premiums asked for spot.

Nearby lead is extremely scarce, and 10.25c. has been paid for odd carloads which could be delivered immediately.

Tin is quiet and easier.

But little is doing in antimony; the price, however, hangs around 30c., duty paid for prompt delivery.

In both steel and iron, the railroad situation has caused a spot market to develop. Pig iron has been advanced 50c. to $1 per ton, and higher prices are asked for various steel products. Ordinary tank plates are now uniformly quoted at 5c., Pittsburg. Ship plates are in enormous demand at 6c., Pittsburg, some of the mills finding it impossible to quote on thousands of tons. Inquiries call for shipments of ship material in 1918 and the early part of 1919. In the past two weeks the railroads have placed orders for at least 300 locomotives. The roads are also buying bridges extensively with a view to strengthening their lines for heavier trains, as well as for commonplace improvements.

It must not be supposed that the activity of the German submarines is entirely responsible for the bad railroad situation. It is a factor, but one not to be compared with the shortage of cars and power, lack of adequate labor and weather conditions.

COPPER

The price of prompt electrolytic is somewhere between 36c. and 37c., but not much is doing, and those actually engaged in the trade find it difficult accurately to gauge the situation. A producer's representative states that there is a little more demand for third quarter, but that, all told, it does not amount to much, while for fourth quarter there is no demand. This interest quotes July at around 32c., and third quarter at 30.50c. to 31.50c., and takes the stand it has nothing to offer prior to July. Second hands, on the contrary, have metal to offer from prompt to July. They quote March at 36c. to 36.50c., and second quarter at 34c. to 34.50c. Prompt electrolytic was bought February 19 at 36.12½c., New York, and the following day some of the same metal—about 500,000 lb.—was offered at 37c., but found no taker. There are those who predict 40c. copper if the railroad situation does not improve, inasmuch as consumers will run short and be obliged to buy where they can and at what price they can. Eastern trunk lines in the past two or three days have been giving preference to the movement of food-stuffs, this being done for obvious reasons. Sheet copper was advanced, February 18, to 44c., base (up 2c.) Copper wire for prompt delivery is difficult to find at 42.50c. Needless to say, the refineries are finding it difficult to obtain adequate deliveries of raw materials and their output is being curtailed. It is figured that the February production will not exceed 180,000,000 lb., although there is capacity for turning out 220,000,000 lb. per month. The London market for spot electrolytic advanced £1 yesterday to £150, against £147 a week previous. The exports, February 1 to 21, totaled 20,394 tons.

ZINC

While spot zinc is scarce, and there have been many reports of fancy prices for immediate delivery, consumers have been curiously indifferent to the state of affairs, at least they have appeared to be, and the market has been quiet. Practically the only business reported has been in February and March delivery. For spot delivery, 12c. is said to have been paid, but confirmation is lacking. For prompt shipment 10.50c., St. Louis, was paid yesterday, while March was quoted at 10.25c. to 10.37½c., and second quarter at 9.75 to 10c., prices which probably could have been shaded a trifle. Brass mill special commands a premium of about 1c. The lack of interest in futures is undoubtedly due to the fact that consumers expect prices to decline when arrivals from the West become more regular. On the part of the producers there is disappointment that prices have not gone to higher levels, especially in view of the flight in copper. The exports February 1 to 12 totaled 6948 tons. The London quotation is unchanged at £47, the price of a week ago. Sheet zinc is without change at 21c. per lb., f.o.b. mill, carload lots, 8% off for cash.

LEAD

Spot and prompt lead is difficult to find on the Atlantic seaboard, and with little or none arriving, it is natural that those in need should pay fancy premiums for immediate delivery. For March shipment, 9.25c. was asked a week ago, and on February 17 consumers paid 9.75c. for the same position. Within the past few days 10.25c. was paid for a carload of spot, and since then, according to report, 11c. and higher has been bid. At 10.25c., the price is the highest since the Civil War, but not much has been done at this level and it is hardly fair to call it the market. The slow and halting deliveries from the West are entirely responsible for the situation. The A. S. & R. Co. continues to quote 8.50c., New York, and 8.42½c., St. Louis, but it is not selling at these figures. The exports February 1 to 21, totaled 365 tons. The London spot quotation, as compared with a week ago, is unchanged at £30 10s.

TIN

Several influences have contributed to an easier tin market. First of all, none of the metal has been lost at sea through the activity of submarines. Secondly, consumers are well covered, as indicated by the large deliveries of last month. For these reasons they are evidently of the opinion that their best course is to stay out of the market and wait for prices to come down. In the past week considerable pressure to sell has been discerned, and the quotation for spot Straits has dropped from 53c. a week ago to 48.75c., yesterday; with March and April deliveries offered at 45.75c., but not stirring consumers to action. The week has been dull and uninteresting. Since the first of this month 3000 tons has arrived, and there is now afloat 3048 tons.

ANTIMONY

Scarcity again tells the story. Shipments in transit from the Pacific coast have been months on the way, yet there is no telling when they will arrive. Meanwhile, spot Chinese and Japanese metal is held at 30 to 32c., duty paid, but there are few buyers. Substantial arrivals will quickly ease the market.

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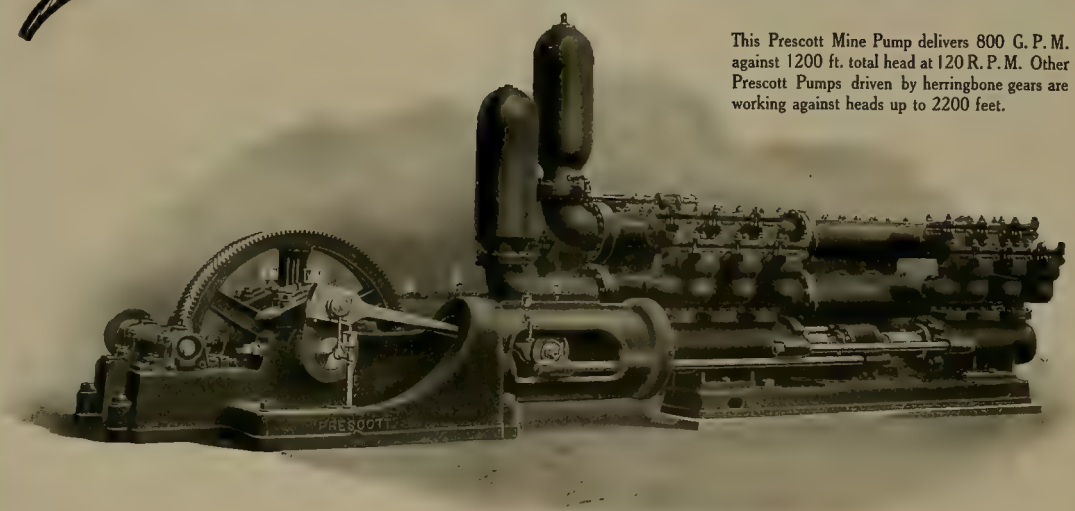

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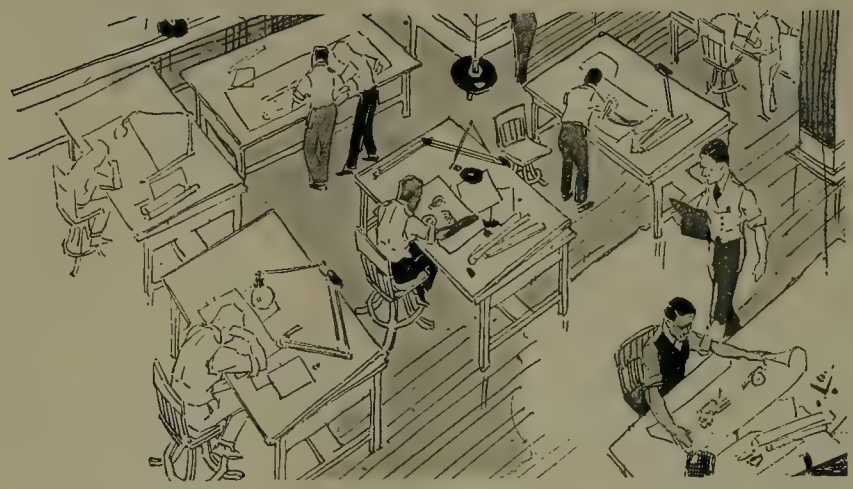

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EDITORIAL STAFF:
T. A. RICKARD - - Editor
COURTENAY DE KALB,
Associate Editor
W. H. STORMS - News Editor

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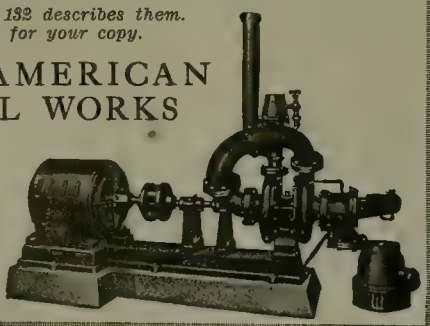

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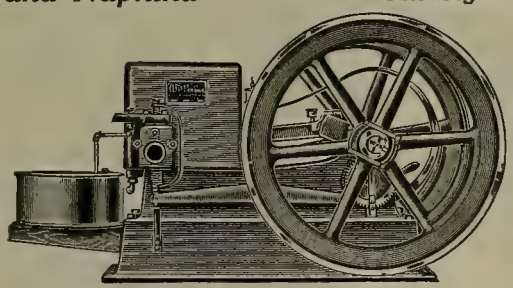

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EDITORIAL

T. A. RICKARD, Editor

WE publish a portion of the oral argument in the Miami appeal at Philadelphia. Our readers will follow with interest the colloquy between the Court and Mr. W. H. Kenyon, speaking for Minerals Separation.

UNITED VERDE EXTENSION is the latest word of mining romance. The prospect that was deemed worthless a couple of years ago earned $6,938,101 in profit last year, equivalent to $6.60 per share. The management estimates the reserve at 1,000,000 tons of 16% copper ore.

GENTLE roasting makes a pleasant noise, if one may judge from the performance of *The Daily Fume,* two copies of which have filtered westward. The hot air that blew through the official organ of the Institoot must have warmed the cold feet of the stand-patters and melted the hard hearts of the kickers. The scrap promoter sends his compliments to his protemporary at New York.

MINING MEN were represented among the victims on the 'Laconia' by William Eva, a prospector from Bishop, California, and the ladies Hoy, the mother and sister respectively of Mr. Austin Hoy, representative in London of the Sullivan Machinery Company. The latter is well-known to many of our fraternity and will receive their sincere sympathy, heightened as it is by his impulsive action in offering his services as a soldier.

MANGANESE is marketed chiefly at Pittsburg, although ferro-manganese is extensively made at the great steel plants near Chicago, by the Maryland Steel Co. at Baltimore, by the Midvale Steel Co. at Philadelphia, and in the Birmingham district, Alabama. More than 50% of the manganese imports into the United States enter at Baltimore, partly due to an enormous development of the steel industry at that city, and partly to the fact that Baltimore is the nearest Atlantic port to Pittsburg.

IN a recent issue we published a copy of the peremptory letter sent by the Minerals Separation people to the users of the flotation process. It appears that this letter was sent to some mining companies that are not using and never intend to use flotation, for example, the Kennedy Mining Co. at Jackson, California, in the Mother Lode region. The manager of the Kennedy mine received the peremptory demand of the Minerals Separation people for specific data concerning his milling operations, and this was followed by the threat of a suit for injunction. Certainly, Minerals Separation has acquired a fatal facility for irritating those engaged in mining.

LABORATORY results of an undigested kind are now being published at short intervals from sundry laboratories of research. These tabulations of results, without incisive comment or definite inferences on the part of the experimenter, renders such publication of small importance. What is needed is a statement of the deductions that may be made from such tests, with emphasis upon such of them as have clear scientific or technical significance, so as to indicate the proper direction for further investigation.

FLOTATION has indeed arrived if it is served with the soup, as was done at a banquet at Colorado Springs when the local Chamber of Commerce dined at a table on which a miniature flotation-machine was exhibited in actual operation. We do not know that this example of levitation added to the gayety of the occasion or that the bubbling stimulated the spectators to unusual hilarity, but it must have excited their intelligent interest in a process that is likely to be the means of expanding the commerce of the region tributary to Colorado Springs.

AMONG the articles the importation of which is prohibited by the British decree of February 24, as announced in Mr. David Lloyd George's speech of February 23, we find "Books, and other Printed Matter, including posters and daily, weekly, and other periodicals, exceeding 16 pages in length." This seems to include the MINING AND SCIENTIFIC PRESS, which has a considerable number of loyal subscribers among the mining engineers resident in London. We shall have to prepare a special edition of our paper so as to comply with the new British regulations, the purpose of which is obvious, namely, to save tonnage. Meanwhile we shall hope that the ferry service across the Atlantic may be restored shortly to its former speed and safety.

REFERRING to the registering of British mining companies in other countries, it appears that the Board of Trade may prevent such a transfer. Aramayo, Francke Mines, Ltd., a company operating tin and wolfram mines in Bolivia, sought to evade the burden of taxation in England by transferring the business to a new company incorporated in Switzerland. The Board of Trade applied for the appointment of a controller in order to stop the transfer. The order was granted and the appeal against it was dismissed. No offence is

charged against the officials of the company, but the British authorities suspect that if the English company changes its domicile to Switzerland it could, under Swiss law, transfer shares and pay dividends to alien enemies. Here is one of the ways in which the War affects the business of mining.

DISCUSSION this week starts with a letter on the flotation of gold ores by Mr. F. A. Beauchamp, who is particularly qualified to deal with such matters because he has been engaged in flotation work, both in mill and laboratory, since 1902, having begun his acquaintance with the process at Broken Hill. He gives the results of tests made on ore from the North Star mine at Grass Valley and suggests that it will be worth while to try flotation on the Rand. The State Geologist of New Mexico, Mr. Charles T. Kirk, records his protest against a 'wild-cat' that is likely to prove voracious. Mr. C. T. Van Winkle returns to the charge, replying to Mr. David Cole. We look forward to the publication of information from the Inspiration mine that will settle this controversy, but we shall be surprised if the results of further tests do not allow latitude of interpretation. A kindred subject, that of the Krupp ball-mill, is discussed by Mr. W. E. Simpson, writing from Canada, but backed by much metallurgical experience in Western Australia. A young Californian engineer writes a timely letter on the occurrence of manganese in California, apropos of an article we published on manganese deposits in another State. This is particularly timely and may be read in connection with the article on manganese in Brazil. Finally Mr. J. D. Hubbard, a metallurgist known to us, makes a friendly protest against a phrase used by Mr. Hoover and quoted approvingly by us. We explain the fallacy in his inference.

OUR contemporary at New York publishes a paragraph commending the mandatory circular issued by Minerals Separation and expressing the pious opinion that "the company has no idea of instituting vindictive methods with anyone who has used flotation without paying royalties for it." This statement is incorrect. The language used by Mr. John Ballot, the chairman of Minerals Separation, and by Dr. S. Gregory, its New York representative, indicates sentiments not to be reconciled with the ladylike policy thus outlined. On the contrary, the Minerals Separation people believe that they have a cinch and they intend to make the most of it; they expect to use the utmost power of the law in bringing infringers to their knees and compelling them to pay not only tribute, but ransom. The circular letter contained questions—such as those asking whether any flotation tests had been made on the ore and, "if so, by whom"—that have to be taken in connection with Minerals Separation's attempt to compel metallurgists to sign an agreement binding them not to disclose anything they learn in a mill or laboratory licensed by Minerals Separation to use froth-flotation. That contract was submitted by us to a good lawyer and he pronounced it "without valuable consideration and unconscionable." There was no *quid pro quo*. It was a bluff, which failed, but it was one more evidence of the real policy of Minerals Separation, namely, to prevent the spread of knowledge concerning the process: to hold to itself not only the right to impose a royalty but the more objectionable power to place an embargo on technical information.

SPECULATION in cyanide is deprecated, we understand, by the one manufacturer of that product in the United States—the Roessler & Hasslacher Chemical Company—which has cut off the supply of several clients that took advantage of the scarcity to re-sell at a profit. The reason for this is obvious. If the price is advanced unduly there would be an inducement for other manufacturers to enter the field and so create unpleasant competition for the one now doing business. On the conclusion of the War the imports from Europe, invited by the high prices obtaining here, would then cause a collapse in quotations, but leave several manufacturers struggling to divide the trade. To this we must add that the Roessler & Hasslacher company has behaved well during the period of stress and their interest in this matter is not far from that of the present consumers. Nevertheless cyanide need not have been scarce had better prevision in the utilization of natural resources governed the selection of a site for new works. The Roessler & Hasslacher Company was fully prepared, by its contract with the Solvay Process Company for raw materials, to meet the normal demand in this country for sodium cyanide. The unfortunate reprisals between the United States and Canada did in fact provoke an embarrassing situation in regard to power. It is surprising, however, that so astute a firm as Roessler & Hasslacher should have resorted to Niagara Falls in the first instance, where power notoriously is not cheap today. Less expensive power undoubtedly could have been obtained at Portland, Maine, or even at Baltimore. Niagara has become recognized as a place for manufacturers to avoid, when cost of power is the controlling factor in their output. It is strange that the remarkable power-resources of the mountains fronting the Pacific Coast should have been overlooked in selecting a site for the manufacture of cyanide, the more so since practically all the consumers of this chemical are west of the longitude of Omaha. The majority of the water-power, developed and undeveloped, within the United States is found along the Pacific Coast, offering the most advantageous power-contracts in America. The problem of the relative freights on finished and unfinished products is accordingly the determining economic question in placing a plant. In this case it would have been wise to have considered the consumer. It is fair to him that a commodity such as sodium cyanide, used almost wholly in the far West, should also be made in the far West, saving cost in transportation of the raw materials that take a lower freight classification than the finished article, and giving security in the matter of adequate power at favorable prices.

Manganese in Brazil

Brazil possesses the greatest known iron deposits in the world. That fact is emphasized in an illuminating article by Mr. F. Lynwood Garrison, printed in this issue. Furthermore, Brazil is recognized as a great producer of manganese, ranking second only to Russia. Mr. Garrison has recently returned from an investigation of the manganese deposits of Minas Geraes, so that his contribution will be read with keen interest. The world is alive to the importance of manganese in these days when war calls insistently for steel. Every abandoned mine, every dump showing the glisten of psilomelane, is being searched and culled. The demand has even summoned the Pacific Coast into the field with its highly silicious manganese ores, which went begging before the War. The total domestic output of manganese ore was only 2785 long tons in the year 1914; California alone shipped 4013 tons in 1915, and an estimate from incomplete returns indicates a production in this State of nearly 15,000 tons last year. The fact that Californian buyers pay about 30 cents per unit for the manganese content, allowing a minimum of 16% silica in the ore, constitutes a measure of the present urgent need of this metal in the manufacture of steel. Mr. Garrison points out the remarkable purity of the Brazilian ores, which usually contain less than 6% of iron, with phosphorus and silica falling well within the Carnegie Steel Company's specifications, which govern in the American market. The manganese shipped from the state of Bahia, Brazil, seldom exceeds 4% in silica, 5% in iron, and 0.017% in phosphorus. The supply of high-grade Brazilian manganese, coupled with the increased shipments of acceptable ores from Cuba, has kept pace with the unprecedented use in this era of mammoth steel production.

If Brazil were blessed with coking-coal equally with her endowments in the other requisites for making iron and steel, she would develop into commanding industrial importance. Wanting in the third essential, a circumstance demonstrated by that distinguished American geologist, Mr. I. C. White, who examined the coal deposts of Rio Grande do Sul and Santa Catharina ten years or more ago, she seems destined to play the difficult political rôle that falls to any country possessed in notable abundance of some of the raw materials necessary to the progress and prowess of giant nations contending for supremacy. The greater ease with which the revolutionary outbreaks in Rio Grande do Sul and Santa Catharina have been controlled by the central government of Brazil during the last decade bears a striking relation to the crushing by Mr. White of any lingering hope that the industrial balance might be completed by fuel derived from these southern States.

The only coal resources that might possibly be brought cheaply to the Brazilian iron and manganese deposits from points geographically related to them, lie in the upper drainage-areas of the northern tributaries of the Amazon, west of its confluence with the Rio Negro, particularly in the watersheds of the Caquetá and Putamayo rivers. A large trade is conducted today by Brazilian steamships between Manáos, the important central Amazonian metropolis, and the coast cities. Navigation extends far up the tributaries, uninterrupted by rapids until close to the Andean foothills and plateaus, where coal is everywhere to be found. These relationships may not be important at the moment, but they undoubtedly possess significance for the future.

Mr. Garrison finds in "the tendency on the part of South American governments to penalize industry" a deterrent upon enterprise. There is truth in this. Brazil has not yet entered into the game of protectionism, a game that can be carried too far. No country has played it in a quite scientific manner, and certainly none has solved the problems of equitable taxation. The fundamental principle applied in collecting revenue in Brazil, however, is based upon use and output. Unwisely applied it partakes of the nature of penalization, yet it contains the germ of an essentially just method of levying contribution upon industry for the support of government, harking back to the ancient customs that have colored nearly all highly developed Semitic systems of taxation in the history of the world. The Brazilians possess a well recognized legal talent, and their new code of laws, which has gone into effect this year, has met with high praise from foreign jurists.

Blue Sky Laws

A report made by Messrs. Horace J. Brown and Fred. M. Miller on a visit of inspection to sundry Arizonan mining districts has been issued by Mr. H. L. Carnahan, the Commissioner of Corporations in this State. His deputies went to Arizona in order to collect information concerning prospects that were being used as the basis of company promotions of a doubtful kind. Such promotions, worked by means of corporations organized in another State, are able, under cover of the inter-state regulations, to evade the Blue Sky law. This law, as our readers know, is one to control the peddling of shares under promises as limitless as the blue sky. Hence the popular name of the enactment. Similar laws have been passed in 26 States and when they have been adopted all over the country they will be even more effective than they are now. Michigan, Ohio, and South Dakota passed Blue Sky laws recently and we note with pleasure that they have been declared constitutional by the Supreme Court, which has decided that the individual States are empowered to deal with the question of fraudulent transactions within their own jurisdiction. The matter is important to those that wish to stimulate legitimate mining by rendering difficult the illegitimate phases of the business. Mr. Carnahan and his staff have done effective work to this end and it is our pleasure to support them so long as they show good judgment, as they have done.

Warning has been issued by the Commissioner of Corporations against the share-issues prompted by the high prices of metals. The big profits made by productive

mines have been used to incite the cupidity of the public and by aid of them a large number of wild-cats, or hopeless prospects, have been foisted upon the share-market. This State has been flooded with the so-called literature of the bucket-shops. It is well for the public to know that the Commissioner's function is to protect them by issuing certificates authorizing the sale in this State of reasonable stocks and by refusing his sanction to the worthless ones. Our own observation leads us to believe that the Commissioner is willing to give a mining venture the benefit of the doubt and that he places his embargo only on those that are thoroughly worthless. The intention is to encourage the organization of legitimate corporate ventures, not to check in any way the proper growth of sane prospecting or of reasonable speculation. Our people should realize this fact—perhaps they do. In any event as spokesman for our domestic mining activities we are glad to bring the matter to the friendly consideration of our readers, asking them to support this method of protecting the only kind of mining that is worth while. Every dollar that gets into the clutches of the unscrupulous peddler of wild-cat shares is a dollar lost to useful development and intelligent exploration. Of course, the Commissioner cannot give the hall-mark of success to any venture; his certificate is not a guarantee, but it does indicate that the subscriber to the stock will have a run for his money: the broker's profit is limited within reason, the promoter is compelled to use legitimately a proper proportion of the money he collects, so that the cash contributed by subscribers is expended in mining and not in filling the pockets of shady adventurers. Some of the stock peddled in California has been offered with the assurance that it had been authorized by the Corporation Commission of Arizona, but it is well that speculators should know that the Arizonan Blue Sky law is different from our own and even if it affords some measure of protection to citizens of Arizona it affords none to those of California. It appears that one of the stocks peddled in this State recently has been the Arizona Ray Copper Company, to which we referred incidentally in an editorial commenting upon the attempt to persuade Arizonan school-teachers that they could become rich quickly. Mr. Brown made a careful enquiry and obtained sufficient trustworthy information to brand as "outright falsehoods" most of the statements made by the promoters of the Arizona Ray. Instead of being "a marvelous bonanza" this is a group of 12 claims discarded as worthless by the Ray Consolidated Copper Company. The claims were considered, by competent men, to cover ground outside the ore-zone, which had been delimited by careful drilling. Experienced engineers advised that "these claims were not worth prospecting, holding, or patenting." Yet this discard has been advertised as "a sure winner, certain to develop into a great copper mine." As Mr. Brown says, it is possible that even such an apparently hopeless piece of ground might be found to enclose a valuable orebody, but, in face of the unanimous opinion of competent judges, it is extremely unlikely. There may be such things as volant, non-ruminating, artiodactyles but the proverb declares them to be "very unlikely birds." In any event, the practical view of the matter is that when ground has been adjudged worthless by competent inspection it cannot be declared rich except by the actual production of ore. One of the most insidious misrepresentations has been the statement that Mr. E. L. Hiatt resigned from the service of the Ray Consolidated "to accept the mine management of Arizona Ray." He left that company's employ six months previously on account of ill health. He obtained 337,500 shares of stock for a one-fourth interest in the 12 claims and $12,500 in real money. Although he became engineer to the new company at a salary of $5000 per year, he has resigned his connection with it, and the fact has been disclosed that he had an agreement with the brokers whereby his name should not be used in connection with the advertising or sale of stock. Another easy way to give verisimilitude to a series of otherwise unconvincing yarns was to turn a broker's assistant into a 'mining expert,' which being done he stated confidently that the Arizona Ray "should contain between 30,000,000 and 40,000,000 tons of ore." An advertised statement that the listed shares were 'treasury' shares was made, evidently to create the impression that the mine was getting the benefit of the capital thus obtained, whereas the fact was that every advance in the selling price meant more profit to the broker but not more working capital for the venture. The finding of some low-grade copper ore by a drill-hole was used to announce "a big copper strike" and the addition of "a third big copper mine to the district." One broker advertised his prediction that the stock would sell at 50 cents "when the ore is struck" and he offered to back his statement with his "own private fortune." If he corrects the difference between the present price of Arizona Ray and 50 cents, he will have made a large hole, as Mr. Brown suggests, in a very considerable fortune. But it is not worth while further to castigate this predatory scheme. Let us add, however, that this hopeless prospect is capitalized for $1,000,000 in 10,000,000 shares, of which 5,000,000 went to the promoters. When treasury stock was being offered as a bargain at 30 cents—three times the par value—it happened that less than 4 cents per share in money and less than 3 cents per share in notes had been paid by the promoters to the company for this stock. This is a good example of real 'wild-catting,' a euphemism that is used much as 'high-grading' is employed as a synonym for 'ore-stealing.' Many other share-peddling schemes of a sinister kind have been perpetrated all over the Southwest and a great deal of money has been raised, to be lost, from among people of small means. The Jerome district is the incubator of a big litter of young wild-cats—otherwise 'frauds.' Let us hope that the Californian bear will continue to make it dangerous for them to invade this State, and may we not also entertain the hope that the State of Arizona will awaken to the dishonor that is being done to her splendid mining industry by such antics.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Flotation of Gold Ores

The Editor:

Sir—I should like to offer some comments on the article 'Metallurgical Problems of the Rand' by Mr. H. Foster Bain, appearing in your issue of February 17.

In his discussion on concentration Mr. Bain brings out some interesting points and suggestions among which, however, there are one or two that do not coincide with the experience of metallurgists in this country. Speaking of flotation he says, "the objection to ordinary wet concentration would apply equally in the case of flotation, and would even be stronger since the air-bubbles are not known to have any affinity for gold." The reason advanced for the failure of wet concentration is "the simple fact that the gold occurs not only in the pyrite but in the quartz."

In my opinion the latter statement would not necessarily predicate the failure of flotation, because for the past two years or more it has been known among metallurgists engaged on flotation work that free gold can be recovered from its ore by flotation when reduced to the right degree of comminution. In confirmation of this statement the following results of actual tests may prove of interest.

The ore on which the tests were made was from a mine in the Grass Valley district, California, and resembled in some respects the Rand ores, the gold occurring both in the pyrite and quartz. The first test was made on an average sample of the ore as delivered to the mill, which for the purpose of the test was crushed to pass 100-mesh screen, then treated by flotation. For the second test an average sample of plate-tailing from the same mill was crushed to pass 80-mesh, and treated by the same process.

Test No. 1. Mill Heading	Weight, %	Assay gold, oz.	Recovery gold, %
Heading	100.00	0.316	100.00
Concentrate	3.08	9.98	97.00
Tailing	96.90	0.01	3.00
Test No. 2. Plate-Tailing			
Heading	100.00	0.12	100.00
Concentrate	3.31	3.33	90.20
Tailing	96.68	0.01	9.70

The plate-tailing sample when crushed to pass 200-mesh yielded a recovery of 95.98% in a concentrate assaying 3.56 oz. per ton and a tailing assaying 0.005 oz. gold per ton.

Another series of tests, equally as interesting, since they give comparative figures of recoveries obtained first by amalgamation, second by cyanidation, and third by flotation, was made on a gold ore from Nevada. The ore was an ideal one for cyanidation, while it was not considered suitable for flotation because it contained a highly colloidal constituent and further the gold was present in the free state with only a minute amount of sulphides. The assay-value of the raw ore was 1.15 oz. gold. Amalgamation on a sample of the material crushed to 30-mesh yielded a recovery of 49%. The recovery shown is undoubtedly low for a free-milling ore but the cyanide-tests indicated unmistakably that the gold was finely disseminated throughout the quartz and was not completely liberated until crushed to pass 200-mesh.

A second sample of the ore was crushed to 200-mesh and then treated by cyanidation, giving the following recovery:

	Gold, oz.
Heading	1.15
Final residue	0.015
Recovery	98.60%

Time of agitation, six hours. Strength of solution, 0.075% KCN. Total cyanide consumption, 1 lb. per ton of ore.

For the flotation experiments a third sample of the material was crushed to 100-mesh, then treated by ordinary flotation using 1 lb. of oil-mixture per ton of ore in a neutral circuit with a pulp-density of four parts of water to one of ore by weight.

	Weight %	Assay oz.	Recovery %
		1.18	
Heading	100.00	1.15	100.00
Concentrate	1.35	71.40	81.60
Tailing	98.65	0.22	19.30

The first assay shown above is the head value calculated from the sum of the products multiplied by its assay. The recovery is based on this figure.

When the ore was crushed to pass 200-mesh and treated by flotation it yielded 92.2% of the gold in a concentrate assaying 33.78 oz. and a final tailing assaying 0.10 oz.

The above tests were selected for the reasons that in the first instance the ore tested was of the same general character as the Rand ore, the gold occurring both in the pyrite and quartz; in the second instance the gold occurred almost entirely in the free state.

In the light of the results obtained by treating these ores by flotation it would seem well worth while to give the same principles a trial on Rand ore since the objections raised by Mr. Bain appear to be unfounded.

With Mr. Bain's suggestion to produce a small propor-

tion of high-grade concentrate, I am in agreement. But I am inclined to think that if flotation could be successfully applied to the recovery of pyrite from the tailing, it would be equally successful in extracting the pyrite from the original ore, and if the ore were crushed fine enough to free not only the pyrite but also the gold locked up in the quartz, it is possible that the whole of the flotation-tailing could be rejected as was shown to be possible in the tests on the Grass Valley ore. The resulting concentrate being comparatively small in amount, could profitably be ground to any degree of fineness found necessary for extracting practically the whole of the gold by cyanidation.

In the event of flotation failing to give a tailing low enough to be discarded, a useful line of investigation would be first to amalgamate on plates, re-grind the plate-tailing to a point at which the pyrite is liberated, treat the re-ground pulp by flotation to recover the pyrite, thicken and filter the flotation tailing and then subject it to cyanidation.

It can be safely stated that flotation is not in any way injurious to a subsequent treatment of the tailing by cyanide. In several instances flotation, used in place of tabling, ahead of cyanidation, has not only materially increased the extraction of noble metals but has also decreased the cyanide consumption as much as one pound per ton of ore as compared with the amount used, when tabling was employed, the reason advanced for this being that elements deleterious to cyanide were removed by flotation and not by tabling.

The present high recoveries prevailing on the Rand leave little room for improvement in this respect, but there does appear to be some scope to simplify the treatment and reduce the cost of operation by making the plant more compact. The above suggestions offer a likely means to this end.

F. A. Beauchamp.

San Francicso, February 23.

Kathleen Consolidated

The Editor:

Sir—On or about December 26 there appeared in the daily press an article advertising very highly the mining property of the Kathleen Consolidated Mining Company of Willard and Estancia, N. M., with mines at Scholls switch, N. M. The property was represented as adjoining the $1,000,000 property owned by Col. Pritchett and Tex. Craven [both names misspelled]. Mr. French, the State Engineer, certain "Phelps-Dodge mining experts" and "State Geologist Kirk" are quoted as saying the ground "is rich in copper *and silver* [italics mine].

Mr. French does not pretend to be a mining man. The Phelps-Dodge men could have given the ground only a casual inspection when there, for it was practically unprospected at that time. I have been along what I am told is one edge of it, but have not seen an identifiable marking or corner. My examination of a near-by property gave me the opinion that the Pritchard-Cavin orebody, as mined at the time of my visit, does not trend toward where I am told the Kathleen claims lie. The district is known to carry no appreciable value in silver.

Briefly, the whole matter appears so glibly and questionably handled that in spite of the good names of Willard and Estancia bankers connected with it, I am disposed to discredit it as looking suspiciously like the old-fashioned species of wildcatting which we all hoped had long ago left the New Mexico diggings. A month of correspondence has failed to get me the opportunity to confirm the statements attributed to me and to others quoted. I have watched for the report upon this ground by any engineer or geologist, but have not seen any nor been advised of such.

Just as in any other mining district, there are barren spots in this (Carecito) district, and I would protect honest investors by holding out in this and similar cases against investment without reputable advice. I consider the above action as part of the duties of my office.

Charles T. Kirk, State Geologist.

Albuquerque, N. M., February 23.

Fine Grinding at Inspiration

The Editor:

Sir—Referring to the further discussion, by Mr. David Cole, of the above subject, in your issue of February 17, I am of the opinion that you, Sir, and the mining public would not be interested in any discussion that is misleading, though doubtless not so intended.

Mr. Cole is mistaken both as to the mill and the test referred to by me. I had not supposed that a combination of cemented pebble lining and manganoid balls would be taken seriously, although the experiment he mentions was undoubtedly tried. The only way that I can explain Mr. Cole's undoubted ignorance of facts, is, that he could not have investigated the matter after the "pebble lining and manganoid ball experiment," and I shall call attention to discrepancies in his statements that show this to be so. Instead of Mr. Cole saying an 8 ft. by 36-in. Hardinge mill, he should have said that in the trials an 8 ft. by 44-in. was used; instead of the mill being direct-connected to a 75-hp. motor, it was belted to a 150-hp. motor. He should have said different types of feeders were used; cast-iron liners were used; steel balls were used; and two drag classifiers were used. There are also other discrepancies in Mr. Cole's statements that I shall not take space to correct now.

It is my opinion that in competitions of crushing or concentration machinery where one set is arranged tandem and the other side by side, no matter what the results show, an element of uncertainty is introduced, and it cannot be proved that a change in arrangement might not have brought about a change in results.

As to the word 'competition,' which Mr. Cole used in his letter of December 9, 1916, and I used later on the same subject, he knows best what he meant. I appreciate that the tests with Hardinge mills may not have been

conclusive and perhaps not satisfactory to all or to the manufacturer. I am not particularly interested in these tests, but I do think that one should be careful in all technical discussion regarding detailed statements and particularly as to their correctness. If this is not done the public who read are misled.

In conclusion, I call Mr. Cole's attention again to the fact that the results of tests between the cylindrical tube-mill and four pebble-mills at Inspiration have not been published. I suggest he do this while we are waiting for "the experiments now approaching the period of fruition." This is for the interest of the mining public who "love truth and fair play."

Salt Lake City, February 19. C. T. Van Winkle.

Ball-Mills

The Editor:

Sir—In answer to a question raised by A. E. Drucker in your issue of February 10, I am able to state from experience that the chief argument against the Krupp wet ball-mill is something of a more permanent character than that "Essen is blockaded," namely, the high cost of maintenance and repairs. By 'Essen,' Mr. Editor, I presume you mean Krupp's mining-machinery factory, which is at Magdeburg, a city devoted to peaceful industry and situated less than two hours by rail from Berlin.

Two classes of ball-mill are made by Krupp, for wet and dry work respectively, and differing but slightly from each other in mechanical design. Having operated both, I am able to make a comparison of their relative efficiency.

The dry machine is highly efficient because of the facility with which it screens and discharges the desired product, a matter which I discussed at some length in a paper on 'Dry Crushing and Roasting at Kalgoorlie, Western Australia,' published by the Institution of Mining and Metallurgy, London, in 1903. The screens form the revolving cylindrical body of the mill, have a comparatively large area, and are graded in decreasing size of mesh from that of being mere holes in the interior cylinder of buckle-plates on which the actual crushing is done, to that of the fine wire-mesh encircling the perimeter through which the finished product is discharged.

In action the oversize particles, before being returned to the centre of the mill for further crushing, perform the function of scouring, cleansing, and vibrating the screens in a manner precisely similar to that of the metallic disc, used by most assayers, on laboratory-sieves, to assist in rubbing through the meshes such particles of pulverized ore as are of the desired fineness in the assay-sample under examination.

With wet pulp, screen classification is infinitely more rapid than with dry material. The undersize is quickly discharged, and what then happens is that the wet angular fragments of oversize in motion on the screen develop a highly abrasive action on all metal with which they come in contact. The wear, therefore, becomes excessive and this is precisely what is found with the Krupp wet ball-mill. Its screen-area is large and consequently, as this is subjected to the greatest amount of destructive attrition, much running-time and money are lost in effecting renewals and repairs. I question if any engineer can be found to recommend such a machine after having experienced the difficulties of its operation. I know of one mining company in Ontario that, having installed a 'wet' Krupp mill and found it unsuitable for the purpose intended, solved the problem by selling it to a neighboring property. By the new owners it was re-constructed and operated for a purpose in which dry crushing was essential, and in this capacity it was thoroughly satisfactory.

At Broken Hill, Australia, in 1906, Krupp wet ball-mills were used extensively for crushing lead and zinc ore to a mesh suitable for table-concentration and flotation work, but, after exhaustive trials, they were discarded in favor of tube-mills. This has been the experience of all other localities of which I have any information. As a competitor against, say, the Marcy or similar mills I can assert that the Krupp machine is not in the running.

Cobalt, February 17. W. E. Simpson.

Manganese in California

The Editor:

Sir—Garnett A. Joslin's article on 'Manganese in West-Central Arkansas' in your issue of December 30, brings to mind the similar occurrence of manganese in California. It is an interesting fact that most of the manganese deposits in the United States are in rocks of marine origin and appear to be genetically related to the deposits in which they are found. A discussion of the origin of these deposits should throw some light on the subject.

Numerous deposits of manganese ore occur in the Coast Range in the Franciscan formation, which comprises a thick series of sandstone, shale, and chert. It is in the chert that all the manganese of commercial importance has been found. The chert has characteristics similar to the 'novaculite' of Arkansas, as described by Mr. Joslin, being hard, flint-like, and very fine-textured. The prevailing color is dark red, but there are also green, yellow, black, brown, gray, and white varieties. Usually remains of radiolaria can be seen throughout the chert, in some places in abundance. These beds of chert are from 1 to 4 inches thick, separated by partings of shale ¼ to 2 in. thick. The beds of shale and chert alternate with remarkable uniformity, and as a whole, have been much twisted and folded, with many overthrust anticlines, and much dove-tailing.

The deposits of manganese are wholly within the chert along zones parallel to the strike of the beds. The deposits are elliptical or lenticular in shape, varying in size from a few feet to 75 ft. long, and from 1 to 15 ft. wide. The ore is composed of the oxides of manganese,

principally pyrolusite, psilomelane, and ochreous wad. In many of the deposits a high content of silica is present. The deposits have a pitch in the general direction of the dip of the chert, with the longer axis parallel to the strike of the beds.

As the manganese deposits are associated with the chert only, it might be assumed that this is the source of the ore, and that the origin of the manganese is connected with that of the chert. The presence of radiolaria at once suggests a deep marine origin, but the associated shale seems to disprove this theory. Andrew C. Lawson, of the University of California, suggests that the silica might have come from silicious springs on the ocean-floor, the silica being in a colloidal form, or ooze, the remains of radiolaria having become imbedded in the silica. The partings of shale are due to the fact that at various times there was an influx of sediment into the sea, during periods of flood, when the streams are heavily charged with the products of erosion. The rate of deposition of the silica would not be affected by this, but the silica would be disseminated throughout the sediment, and a deposit, rich in silica, would be the result. E. F. Davis, of the University of California, found remains of radiolaria in the shale also, and an analysis showed it to be high in silica.

If the hypothesis that the chert is of marine origin be accepted, it is easy to account for the manganese oxide. Manganese hydrates, with ferric hydrates, are widely distributed in marine deposits, especially in abysmal regions, where they occur as a coating, or as nodules. During the expedition of the *Challenger* in 1878, the trawl brought up great quantities of manganese nodules from nearly all depths below 2000 fathoms. Many specimens of chocolate clay (colored by manganese) were obtained in the Pacific and Indian oceans, and objects such as rocks, coral branches, and shark's teeth were coated with a black dendritic manganese oxide.

The source of the manganese is supposed to be in the basic volcanic rocks and minerals with which the nodules are associated in deep-sea deposits. The manganese of these rocks is transformed first into carbonate and subsequently into oxides, which, on deposition in the ooze, take a concretionary form around various nuclei. So, it can be seen that in deep-sea deposits manganese may occur sparingly throughout the chert, or it may, by accretion, in places, form large masses.

Analyses of the chert by Mr. Davis showed that the main constituents were iron oxide and silica, and that it contained about 1% of manganese oxide. Veinlets can be seen in the chert in many localities, and it is common to find stains of manganese oxide on the chert remote from a deposit of the ore. Analyses, microscopic examinations, and the presence of coatings of manganese oxides on the chert indicate that the oxide is sparsely disseminated throughout the beds. The workable deposits are secondary concentrations, and in some of the deposits the manganese replaces the chert, the original structure of the beds being perfectly retained.

Little development work has been done on these deposits as a whole, and their extent in depth has not been determined.

DON CARLOS BILLICK.

Latouche, Alaska, January 27.

Belgian Relief

The Editor:

Sir—In your issue of February 17 an editorial appeared under the heading of 'Belgian Relief.' In it you quote Mr. Hoover, as follows: "The man who is swayed by his emotions is usually a man of small intellect, *and the man of small intellect is always a man of small pocket-book*" (the italics are mine). Then the Editor adds: "With that we agree; emotional excitement will not help the little ones in Belgium."

Now, Mr. Editor, did you really mean that, or were you and Mr. Hoover joking? The man of small intellect is *always* a man of small pocket-book"? Wow! That chunk hit me right between the eyes, for I am a man of small pocket-book, and therefore ——!!! As I have a few poor relations, I have only one share of Belgian Kiddies, Ltd., pinned up on my wall, and I know of several of the greatest men in the history of the world, names that will live, that were men of small pocket-book. I looked carefully in the following issue of the PRESS to see if someone of larger intellect than mine had not noted the hole that a great engineer and a great editor had stepped into together, and commented thereon.

Dear Mr. Editor, please tell me that you two boys did not mean it, for I do not wish to place those whom I have held in such high esteem in the same category with Edison on Religion, Ford on Peace, and Roosevelt on Pre-Election Promises.

J. D. HUBBARD.

Paradise, California, February 25.

[Our friend has made an illogical inference. He errs in assuming that one "all," or "always," includes the other. We did not say that all men of small pocket-book are men of small intellect. The fallacy will appear by applying the syllogistic method. Letting A equal all men of small intellect; a equal some men of small intellect; B and b respectively all and some men of large intellect; C and c respectively all and some men of small pocket-book. We have affirmed that $A = c$. Our correspondent has affirmed $C = A + b$, which is a quite different proposition from the unfortunate but not unreasonable state expressed by $b = c$. To this we shall add our regret to have seemed to say anything unkind concerning men of small pocket-books, to whom we and most of our friends belong.—EDITOR.]

FROM ALL QUARTERS complaints are made that contracts entered into for the supply of molybdenite have been very imperfectly fulfilled. In addition to some scarcity of the ore, the freight congestion has played havoc with the market and on account of the inability to obtain raw material in quantities, it is impossible now to secure from any quarter a quotation on ferro-molybdenum for reasonable delivery.

The Mining Industry of Brazil

By F. Lynwood Garrison

INTRODUCTION. In its early history, that is to say, about the years 1700 to 1820, Brazil was one of the important mining countries of the world. It is estimated to have produced within that period as much as thirty million ounces of gold and it is believed that there was exported clandestinely from one-fifth to one-half as much more.

The governmental tax exactions in the early days were undoubtedly onerous, being at one time as much as 20% of the gross output. Various schemes for exacting tribute were tried from time to time, despite protest, but the spirit of the Government has not changed even to this day, although a more liberal view of such matters has been shown at times. The tendency of nearly all South American governments to add tax on tax upon mining industries is short-sighted, a mistaken policy to which may be attributed much of the present backwardness of these countries. Revolutions are bad enough, but heavy and unfair taxation is fatal.

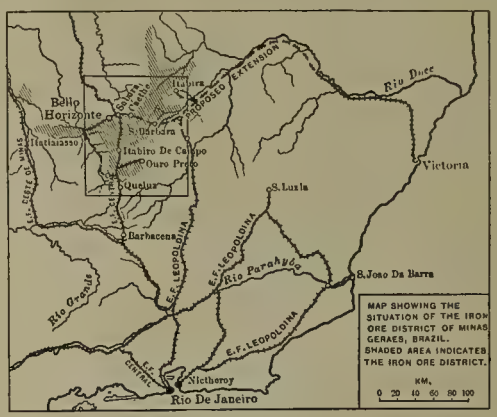
The mining industry made a good start in Brazil, but now, although this country has an area as large as the United States, its mines are few and contribute little to the general wealth of the world. Outside the State of Minas Geraes it may be said that mining in a modern sense does not exist and in that State there are but two gold mines and perhaps a half-dozen manganese properties which are in active production.

It is my purpose to discuss a few facts regarding the mineral resources of Brazil that are known to many mining engineers and economic geologists, but about which the general public is profoundly ignorant.

IRON. The extent and value of the iron deposits in Minas Geraes was first authoritatively pointed out by Orville A. Derby in a communication read before the eleventh Geological Congress held at Stockholm in the year 1910. Dr. Derby said: "Practical iron men and geologists who have visited the various parts of the district hesitate to pronounce impossible estimates that at first sight seem utterly preposterous. Henri Gorceix, founder and for many years director of the Mining School at Ouro Preto, who has a very intimate knowledge of the district, stated in a public lecture in 1881 'I have estimated at five billion tons the iron ore that Minas Geraes might furnish and I fancy that I should not be exaggerating if I were to double this estimate.' "

A careful reading of the text of this communication as printed in the official publications of the Congress and entitled 'Iron Ore Resources of the World,' Vol. II, p. 819, does not show that Derby confirms this statement directly, but he does so by implication and further quotes from a private letter of R. A. F. Penrose in which Mr. Penrose gives credibility to these estimates, which are so enormous it is important to make clear the responsibility and reliability of those who made them. Derby, it may be said, was, at the time of his death two or three years ago, the highest authority on Brazilian geology and Penrose had himself visited many of these iron ore deposits, so he must have been in a position to form some definite conception of their importance; moreover, being an able mining geologist, his views will carry weight in the United States.

Derby further stated that many years ago he had observed an identical ore formation at various points along



BORROWED FROM *Economic Geology*.

the Sao Francisco river and although his examination was but cursory, it seemed possible these iron deposits may be comparable as to quality and quantity with those of Minas Geraes.[1]

The Minas Geraes ore is predominately hematite—hard, dense and specular—having, according to Harder, the following composition:

	%
Iron	69.65
Phosphorus	0.0125
Silica	0.24
Combined water	0.38

There is, of course, much ore inferior to this, but even the poorest (*canga*) ranges between 50-65% iron and 0.1-0.3% phosphorus. On page 153 Harder gives a table of average analyses of iron and phosphorus for the different grades of ore.[2]

It is not my present purpose to expatiate upon this economic fact, save to add that its importance has been recognized and large areas of these iron-ore lands have passed into American control. Moreover, the British

[1] Trans. A. I. M. E., Vol. L, page 143.

[2] *Ibid.*, p. 822.

company operating the old and famous St. John del Rey gold mine has also acquired large holdings in the neighborhood of this mine with the view to producing iron ore when a favorable market has been established.

The geology of the Minas Geraes, or Itabira, iron formation has not been worked out; the German geologist Gathmann attempted to prove the ores to be only secondary residual, and surficial formed by the leaching of the silica from an iron-bearing quartzite for which the term 'itabirite' has been adopted.[3]

In *Economic Geology* of March 1914 Harder[4] answers this criticism and observes: "The question, as to whether the iron ores of Minas Geraes are the result of original deposition or of surface concentration, is one of great practical importance. If the ores are the result of surface-weathering agencies, then they cannot be expected to go to any great depth, except perhaps along important water-channels such as have been found to occur in some of the deposits of the Lake Superior district. If, on the other hand, they are the result of original deposition, then the depth to which they might continue is indefinite, and the changes to be expected are only such as would result from processes affecting original sedimentation. *The facts seem to me clearly to prove the latter view.*" Harder is a mining geologist who has made a special study of the Brazilian iron-ore deposits as compared with those of the Lake Superior region. The above italics are mine because I wish to emphasize an opinion that ought to carry great weight.

It would seem, therefore, if these views and opinions are worth anything, that it will be only a question of a comparatively short time before a large iron-ore mining and shipping industry is established in Brazil. At present heavy shipments cannot be made because the existing railways were not designed for such traffic and there are no proper storage and shipping facilities at Rio de Janeiro and Victoria, the two seaports through which this traffic would have to go.

The Central railway, owned by the Government, which runs from Rio de Janeiro through the heart of the mining districts of Minas Geraes, is now handling a large tonnage of manganese ores at a price to the shipper of something like $1.25 to $1.50 per ton for an average haul of 300 miles.

When we consider that the ton-mile cost of operating the Brazilian railways is 7.04c., the highest of any system in the world, this rate must be considered low.[5] Nevertheless it would probably be necessary to build an entirely new railway system for handling the enormous tonnage that a great iron-ore mining operation would require or else re-construct the old railways, for as they are now there is scarcely a tangent in any of them where it has been possible to put a curve.

MANGANESE mining in Brazil was commenced in the state of Minas Geraes about the year 1893 at a place called Miguel Burnier on the Central railway. The industry developed slowly and has been carried on intermittently for a number of years; when exchange was low, that is when the milreis was worth from 20 to 25 cents, it flourished, but higher rates without a corresponding decrease in wages seriously curtailed the output.

With the outbreak of the Great War and the complete cessation of manganese shipments from the Caucasus, the Brazilian production has increased rapidly; moreover, new and larger deposits have been opened up in the Lafayette or Queluz district, so today the Morro da Mina is not only the most important one in that region but is probably the largest manganese mine in the world, and curiously enough this property some ten or fifteen years ago in its then partly developed condition, was considered almost worthless, a circumstance attributable to the lack of knowledge concerning the geology of the region in general and of the genesis of the deposits in particular.

Brazil is now producing more manganese than ever before, the prices are high, the profits large, and were the handling and shipping facilities at Rio de Janeiro what they ought to be, the returns to the miner would be enormous. The Morro da Mina mine is owned and operated by Brazilians; the Cocuruto, the next largest, has an English manager and is controlled by Belgian interests. Practically all the manganese ore produced in Brazil is sent to the United States; England and France obtain their supplies from India.

The quality of the Brazilian manganese is distinctly good, averaging between 45 and 50% metallic manganese; the phosphorus and silica contents are low, with only 5 to 6% of iron.

Manganese ores are rather common throughout Minas Geraes and Bahia but they have not been sought systematically except in the former State and even there the area thus far known and developed is relatively small.

GOLD. There are at present but two going gold mines in the whole of Brazil, the famous old St. John del Rey and the Passagem. The former produces about $2,000,000 and the latter some $500,000 of gold per year.

The St. John del Rey is one of the classic mines of the world and has been in operation continuously since 1830. It was first opened in 1725 and was supposed to be exhausted at the end of that century. It also has the distinction of being the deepest mine in the world, having by now probably reached a depth of over 6500 ft. vertical. Notwithstanding the large production of these two properties, their methods of milling are not up to date. This is not any reflection on the management, which, judging from what one hears in Brazil, must be, all things considered, excellent.

The geology of the gold region in central Minas Geraes has been studied by Derby, Branner, Scott, and others. It is not my present purpose to more than refer to it. There seems to be no doubt that many of the gneisses and granites of this region contain appreciable quantities of gold, hence the alluvial deposits were rich in the early days and the source of much if not most of the

[3] *Zeitschrift für Praktische Geologie*, XXI, May, 1913.

[4] See *Economic Geology*, Vol. VI, 1911 and Vol. IX, 1914.

[5] The ton-mile rate in the United States is 0.729c.; in France, 1.18; in Germany, 1.24.

$600,000,000 worth of gold produced by Brazil in the early days of its settlement.

Readily accessible placers have all been pretty well exhausted by the native washings, but no doubt there are many opportunities where modern hydraulic and dredging methods can be applied successfully just as was the case in California after the exhaustion of the easily worked stream and bench gravels. The present seems an interim period in Brazil between the primitive methods of the past and the modern washing systems of a mechanical age.

The quartz-gold deposits in Minas Geraes and Bahia are uniformly low-grade, not to say lean, and this condition has been a great drawback to the development of lode mining. There have been some rich discoveries, like the Gongo Socco, where the auriferous jacutinga was found to be composed in great part of laminated masses of gold weighing from a few grams to several kilos.[6] Two-thirds of the gold extracted from this mine was in masses, plates, and threads of native metal, and one-third was disseminated through the adjoining matrix, but as is always the case in such rich treasure-trove, the extent and volume is limited and experienced mining men always regard such mines with suspicion.

DIAMONDS were discovered in Brazil in the second half of the 18th century and the recovery of them from stream gravels by simple washing methods continued with more or less success until the discovery of the South African deposits in 1871. Although Brazilian diamonds are said to be the best in the world, being harder and of better color than any others, there is not today in Brazil any properly organized and equipped diamond-mining industry. The small amount of Brazilian diamonds that reaches this market and that of Europe is derived from alluvial washings in which a wooden bowl and an iron scraper is all the equipment required by the native.

All diamonds in Brazil are the property of the Federal Government from which the miner must lease or obtain a concession. Such grants, however, are easy to obtain and it is only after the operator begins to make money that the Government is likely to make trouble for him.

The geologic conditions governing the occurrence of diamonds in Brazil have not been worked out, although a number of articles have been published on the subject. It seems the gems are found somewhat sporadically in the alluvial débris of the sedimentary rocks—sandstones and conglomerates—but they probably had their origin elsewhere. Occasionally the diamonds are found embedded in these sedimentary rocks, evidently having been part and parcel of the ancient sediments and detritus of which they are composed.

According to Derby, there are enormous areas of such diamond-bearing rocks in what is known as the Lavras region of Bahia, but only a relatively small part of this area can be worked with profit by the processes now in vogue in the country. This distinguished geologist believed that with the use of proper engineering methods and the abundant water-power the region affords, an effective solution of the problem may be found, but that it is one for the engineer rather than the geologist—in short, the probabilities of a successful outcome are strong enough to justify serious study and experiment.[7] It is certain that the present Brazilian diamond-mining practice cannot compete with the well-equipped and technically directed South African mines.

A characteristic of the Brazilian diamond deposits, especially in Bahia, is the frequent occurrence of the black, gray, or brown material known as *carbonado*, which is an amorphous form of diamond used in drilling.

In Bahia rough diamonds are prepared for the market in a curious way. Stones with flaws or a rough skin are

PART OF BRAZIL, SHOWING MANGANESE DEPOSITS.
(1) Bahia; (2) Miguel Burnier-Ouro Preto; (3) Lafayette; (4) Corumba.

charged into a crucible and heated at a cherry-red temperature for three or four minutes, then the crucible is removed from its charcoal bed, a tablespoonful of potassium nitrate is thrown over the stones and the crucible well shaken. As soon as the fume has gone off, the diamonds are taken out, washed, and counted; it is usually found they have lost about 8% in weight, but doubled in value. Just what happens during this process, I have not heard explained, but evidently some of the carbon of the skin or surface of the stones has been burnt out or oxidized.

The genesis of the Brazilian diamond deposits has long been a geologic puzzle. As previously mentioned, in Bahia the diamonds are found associated with the débris of certain sandstones and conglomerates and actually in the rock itself. It seems highly improbable they had their origin in these sedimentary rocks, but more than likely they entered into the mechanical composition of the sandstones and conglomerate beds like any other pebble. It is true, in certain localities, as at Sao Joao da Chapada, 12 miles west of Diamantina, in Minas Geraes, diamonds have been found in quartz veins that accompany a rock of unknown character containing plates of specular iron, tourmaline, and pyrite. In the Diamantina region, the diamond occurs *in situ* in its original matrix in fairly well-defined veins.[8]

[6]H. K. Scott, Trans. A. I. M. E., Vol. XXXIII, p. 418.

[7]*Economic Geology*, Vol. I, page 140.

[8]Derby, *Am. Jour. Sci.*, Vol. XXIV (1882), p. 42.

According to Branner, the diamonds of Bahia are found in what is known as the Lavras series of quartzites, which are probably of Carboniferous age. Dr. Branner speaks of this sedimentary series as the immediate source of the diamonds and seems to lean toward the belief they also had their origin therein.[9] While it would be presumptuous for me to question the view of one so much better qualified, I cannot see any good reason for not assuming that the diamonds originated in the primal peridotites and dunites of the neighboring granitic and gneissic areas. It is certain these rocks are now associated with serpentines, which, as is well known, are derivatives of ultra-basic rocks, like peridotite.

Other Minerals. There are great areas of old crystalline rocks in the large States of Minas Geraes and Bahia with which are intimately associated important deposits of iron, manganese, chrome, gold, mica, copper, and, as we have seen, perhaps also the diamonds. The iron, manganese, and chrome may be made of immediate commercial value because they exist in large quantity and can be mined and shipped without previous preparation or treatment of any kind.

The present outlook for gold mining in Brazil is not hopeful; on the whole its history has been disappointing.

Attempts have been made to mine mica and monazite sand from the unquestionably large and valuable deposits of these minerals in the State of Bahia, but for one reason or another they have been discontinued. In Minas Geraes the mica industry seemed promising at one time and an interesting paper was written upon the subject by H. Kilburn Scott.[10]

Of copper very little is known, although it has undoubtedly been found in a number of localities. I was shown some samples of excellent ore said to have come from near the Jaguarary railway station in the northeastern corner of the State of Bahia. It is the locality mentioned by Branner in his article published in the *Engineering & Mining Journal* of May 22, 1909. These copper deposits have never been seriously prospected and are, I understand, quite a long distance from the railway.

During the years 1904-1906, the Brazilian government employed I. C. White, of West Virginia, to make an examination of the coal deposits known to exist in the States of Rio Grande do Sul and Santa Catharina with the view to their economic development. Numerous borings were made, some of them as deep as 1000 ft., and several seams of coal were cut ranging in thickness up to seven and eight feet, but all of very inferior quality. Some of this coal is said to have been mined and sold, but in its raw state it was unsuitable for commercial purposes and could be made saleable in competition with imported coal only after having been washed, cleaned, and made into briquettes.[11]

So far as known, coal has not been discovered in any other part of Brazil and as by far the greater part of this vast country lies well within the tropics, it is unlikely that any considerable amount of good coal ever will be, since, for some never-satisfactorily explained reason, coal fit for steam or commercial purposes is exceedingly rare in tropical countries.

The future development of metallurgical industry in Brazil will evidently have to depend upon a supply of hydro-electric power for smelting purposes, or else the use of expensive imported coal. Fortunately there are plenty of water-power sites in many parts of this enormous country, especially in Minas Geraes and Bahia, where power is most likely to be wanted and where the more important metalliferous deposits have so far been found.

It cannot be expected, however, that such highly technical industries are likely to be initiated and financed by the Brazilians themselves unaided by foreigners, because the natives lack not only the technical skill but also confidence in themselves to carry out the work to completion, which is the logical corollary to inexperience in such matters. Moreover, there is always a haunting dread of governmental interference and excessive taxation once an industry becomes profitable.

This undoubted tendency on the part of South American governments to penalize industry comes from ignorance of sound economic principles on the part of the educated and governing classes. In South America there is no such thing as public opinion, as we understand it, for most of these countries are ruled by an oligarchy composed of a few hundred families. No one knowing South America will question that this is probably the best system of government that can be maintained, provided always the governing classes are alive to their responsibilities and sensitive to the terrible risks both at home and abroad that misgovernment may involve.

It is exceedingly doubtful if the Monroe doctrine can be invoked continuously to protect misgovernment. South America is today the only large part of the habitable earth not owned or controlled directly or indirectly by one of the great powers, with the exception of China, and it is perhaps a question if China is not herself a great power. In Brazil there are about 1,500,000 Italians and 200,000 Germans, and the Japanese are beginning to come quietly in considerable numbers to the Southern states as well as all along the West Coast of South America.

Practically the whole continent, especially Brazil, possesses enormous undeveloped resources, lacking only the magic touch of capital, technical direction, and honest laws to foster and protect enterprises certain to yield returns equal to, if not surpassing, those in any other field of foreign investment.

As I have intimated, Brazil's contribution to the metallic wealth of the world is at present practically negligible. The causes have been variously explained, such as the comparatively recent liberation of the slaves in 1888. These people represented then, as now, the

[9] *Am. Jour. Sci.*, Vol. XXXI, June, 1911, pp. 483-490.
[10] Trans. Inst. Min. & Met., Vol. XII, pp. 351-365.
[11] Trans. A. I. M. E., Vol. L (1914), p. 157.

bulk of the laboring classes and often when they don't want to work they won't, and it is very easy to say "won't" in a tropical or semi-tropical country where food may be grown with little effort and clothing is not a matter of fundamental importance. A more potent obstacle is the fact that Brazil is an agricultural country

WHARVES AT RIO DE JANEIRO.

Rio de Janeiro is equipped with an excellent system of modern docks, but they are not suitably arranged for handling ore in bulk. Consequently the manganese ore, upon arriving at the railway terminus, is transferred from the cars to lighters, by which it is taken to one of the small islands in the harbor, where it is stored in heaps until a shipment is to be made. In that event the ore is re-loaded into lighters that are then towed alongside the vessel, which is usually anchored out in the bay some distance from shore. The ore is thus necessarily handled four times from cars to vessel as against once in good practice wherein the car discharges its load by gravity didectly into the hold of the ship.

whose people are conservative, unimaginative, and ignorant. All these causes have had their influence, but such reactionary tendencies could easily be overcome by some show of intelligent interest on the part of both

MORRO DA MINA, BRAZIL.

the Federal as well as the various State governments. Thus, for example, we have seen the able and self-sacrificing geologist Derby, who labored many years faithfully and unselfishly to study and make known the mineral resources of this enormous country, given a grudging and half-hearted support that in the end appears to have broken his spirit, and probably had much to do in bringing about his tragic and untimely death.

This is not said in a spirit of unfriendly criticism; on the contrary, I wish simply to point out that any nation without a well-established mining and metallurgical industry is certain to be vulnerable in this day when munitions are as important as men. As I have tried to show, Brazil has an abundance—with the exception of coal—of raw material for the maintenance of a great metallurgical industry, yet I doubt if she produces any military munitions whatever. The logic of the situation would seem to be for the Brazilians to make every effort to expand and encourage their industrial development as rapidly as possible. Every inducement should be offered to American capital and enterprise; at present the United States is the only country prepared to provide it, and once an industry is fairly well started and is prospering, a policy of nagging interference, graft, and unfair taxation is likely to be fatal or bring about diplomatic interference, all of which is certain to discourage American investment in Brazilian enterprises.

Americans, as a rule, are unaccustomed and rather adverse to foreign investment; there are so many opportunities at home. Business abroad must be made very attractive in order to entice timid dollars into the uncertainties and worries of a foreign field. American capital may be plentiful, but it is well to remember that the whole world is now seeking it with an unprecedented zest, mainly to carry on a dreadful war; when that is over, Europe is likely to be all but bankrupt and must be rehabilitated. Moreover, Europe can get capital on easier terms than South America. The present is, it seeme to me, the best opportunity Brazil has ever had to cultivate closer relations with the United States, and it might be well for both countries were this fact mutually realized.

EXPERIMENTS in the purification of crude sulphur containing arsenic have been continued at the Bureau of Mines experiment station at Berkeley. A centrifuge has been equipped with an electrically heated cup so that sulphur may be held molten and centrifuged for several hours at a time. In studying the solubility of arsenic tri-sulphide in molten sulphur it has been found that a solution containing 4% arsenic shows no indication of depositing a precipitate of arsenic sulphide after standing several weeks at 121° C. So far there has been nothing to indicate that a separation of arsenic sulphide occurs when its solution in sulphur freezes. This solubility work is being continued, and further experiments on fractional distillation of sulphur-arsenic mixtures are being arranged.

THE TERM, 'SLASH PINE,' is popularly applied to several southern pines, notably the loblolly, with which the true slash pine is often confused because of its close resemblance. The slash pine is also sometimes called Cuban, swamp, or 'she' pine.

Secondary Economic Minerals of California

By Herbert Lang

Aside from the precious metals, and the ores of lead, copper, mercury, and zinc, which have long been the object of the prospector's search, there are a large number of minerals of secondary importance in California to which it would be well for prospectors to give attention. That he may have some idea of the condition of the trade in these secondary minerals, the accompanying data have been prepared. The substances may be classified as follows:

1. Abrasives: Minerals used for grinding and polishing; as quartz, jasper, pumice, garnet, feldspar, and rotten-stone.

2. Detersives: Minerals used for cleaning purposes, being incorporated in soap; as quartz, pumice, and infusorial earth.

3. Emollients: Generally styled 'lubricants,' and used either by themselves or with some liquid, to lessen friction. These are mica, talc, clay, graphite, and soapstone.

4. Absorbents: The property of which is to take up liquids. These are fuller's earth, infusorial earth, and magnesite.

5. Fillers: Used to adulterate or give weight to paper and other fabrics. Clay, talc, soapstone, and mica are the principal fillers.

6. Fertilizers: The phosphates and potassium-bearing minerals.

7. Non-conductors: Substances that are poor conductors of heat. Any mineral in the form of powder does this, but infusorial earth, magnesite, and mica are pre-eminent.

8. Paint-stock: Substances used to impart 'body,' color, or wearing quality to paint. These are barytes (sulphate of baryta), ochre, talc, manganese, silica, gypsum, and pumice.

9. Reagents: Substances valuable for their chemical properties, such as chrome, infusorial earth, quartz, limestone, and magnesite.

10. Refractories: Useful for their heat-resisting properties, such as chrome, clay, quartz, soapstone, and magnesite.

This classification might also include structural materials, the rocks and minerals used in cement manufacture, as well as those valuable for their decomposition products, obtained through chemical processes, but it is better not to include substances that are in an intermediate class between metallic ores on the one hand, and building-stone, road-metal, and soil on the other. This classification is found to embrace materials that are used solely in the powdered form, which is a distinguishing characteristic. The investigator is surprised at the amount and variety of mineral powders going into trade and manufacture. It would seem that any stone, if finely or even coarsely powdered, may be saleable for some purpose. It is obvious, from this classification, that the simpler chemical composites are preferred, the value for the various purposes indicated being lessened as the substance becomes more complex. Thus, a powdered rock of high complexity, such as many of the silicates, would probably have no value except as soil; while each of its constituents separately would probably be of value for some purpose. There is a curious similarity in the price that different pulverized minerals bring—$20 per ton, as a rough average. The following list exhibits the variations. The prices mentioned are those of pre-War times, because the present disturbed condition of the market precludes an exact statement of what the materials now bring in the local market.

Name	Price per short ton	Annual consumption, tons
Chrome	$17.00	1,500
Barytes	20.00	1,000
Dolomite	11.00	3,000
Garnet	13.00	4,000
Gypsum	3.00	5,000
Infusorial earth (crude)	10.00	8,000
Infusorial earth (ground)	15.00	2,000
Mica (ground)	40.00	250
Ochre (ground)	17.00	1,000
Pumice	25.00	1,500
Talc (ground)	18.00	3,000
Quartz (crude)	2.50	10,000
Quartz (ground)	12.00	1,000
Manganese (ground)	25.00	250
Slate (ground)	22.00	500

These are San Francisco prices, and are a fair average of price and consumption before the War. In some particulars the trade has expanded, in others it has contracted; but on the whole the prices have increased greatly, and, owing to the introduction of improved processes and greater demand, the industries here represented are on an improved footing.

The principal trades and their requirements are represented in the following:

Acid Makers: Pyrite, nitre, brimstone, salt, fluorspar.

Asphalt Paving: Bituminous rock, gravel, limestone, infusorial earth.

Auto Tire-Powder: Soapstone.

Brick, Tile, and Terra-Cotta: Clay, talc, manganese, fluorspar, feldspar, ochre, willemite.

Cement Makers: Limestone, clay, slate, gypsum, ochre, fluorspar.

Cement Shingle Makers: Ochre, jasper.

Chlorination Plants: Salt, manganese.

CHEMICAL MANUFACTURERS: Salt, quartz, feldspar, fluorspar, manganese, chrome, infusorial earth, magnesite, dolomite, limestone, pyrite, baryta.

DRUG MANUFACTURERS: Pumice, talc, fuller's earth, silica.

DYNAMITE MANUFACTURERS: Infusorial earth.

DRY BATTERY MAKERS: Manganese.

ELECTRIC SUPPLY MAKERS: Mica, talc, asbestos, soapstone.

FIREBRICK MAKERS: Clay, chrome, silica, sand, magnesite.

FERTILIZER MAKERS: Limestone, gypsum, phosphate rock.

FLOUR MILLERS: Ground limestone.

GLASS MAKERS: Silica-sand, feldspar, fluorspar, manganese.

INSULATION (of boilers, etc.): Infusorial earth, asbestos, magnesite, talc, amphibole.

LITHOGRAPHERS: Lithographic stone, pumice.

LUBRICANT MAKERS: Mica, talc, steatite.

METAL-POLISH MAKERS: Silica, pumice, infusorial earth.

OIL REFINERS: Fuller's earth, silica.

PAPER MAKERS: Talc, clay, quartz, mica, magnesite.

PAINT AND VARNISH MAKERS: Talc, clay, ochre, manganese, limestone, silica, barytes, pumice.

PORCELAIN AND CHINA MAKERS: Feldspar, quartz, fluorspar.

PUTTY MAKERS: Ground limestone.

POULTRY-SUPPLY MAKERS: Limestone, sea-shells, crushed granite.

MAGNESIA-CEMENT FLOOR MAKERS: Magnesite, marble, dolomite, jasper, talc, silica, pumice, infusorial earth, ochre.

ROPE MAKERS: Talc, clay.

ROOFING MAKERS: Quartz, jasper, talc, infusorial earth, slate, mica, soapstone, clay, marble.

REFRIGERATOR AND FIRELESS-COOKER MANUFACTURERS: Infusorial earth, talc, asbestos.

RUBBER MANUFACTURERS: Steatite, talc.

RICE FACTORIES: Ground limestone, talc.

SCOURING-COMPOUND MAKERS: Pumice, silica.

SHOE MAKERS: Garnet.

SILICATE OF SODA MAKERS: Infusorial earth.

STONE FINISHERS: Pumice, rotten-stone, silica.

SOAP MAKERS: Talc, pumice, silica, soapstone, borax.

SYRUP MAKERS: Infusorial earth.

STEEL AND IRON MANUFACTURERS: Iron ore, chrome, manganese, talc, graphite, magnesite, dolomite, fluorspar, quartz, limestone.

SMELTERS OF COPPER AND LEAD: Chrome, quartz, manganese, fluorspar, limestone, dolomite.

SOUND PROOFING MAKERS: Infusorial earth.

SAND PAPER MAKERS: Flint, quartz, garnet.

SUGAR MANUFACTURERS: Infusorial earth, limestone.

STONE (artificial) MAKERS: White sand, quartz, marble-dust, limestone, granite, jasper.

TANNERS: Talc, chrome compounds.

WALL PAPER MAKERS: Mica, talc, magnesite.

WOOLEN MANUFACTURERS: Fuller's earth.

The commercial uses of the different minerals are recapitulated in the following:

ASBESTOS: In fire-proof paints, wall-plaster, patent shingles, roofing, incombustible curtains for theatres, cloth, rope, felted boards, asbestos-cement, paper-stock; in the fire-proof packing of safes and vaults; and in the non-conductive covering of boilers, steam-pipes and flues.

BARYTES: In the manufacture of paint, paper, rope, rubber; and of various chemicals, such as the carbonate, chloride, hydroxide of barium, and lithophone.

CHROME: In the manufacture of chrome-steel, used in making refractory brick, and in the construction of open-hearth and other furnaces used in steel manufacture. Its salts are used in tanning and in the manufacture of dyes and colors.

DOLOMITE: As a refractory lining for steel-furnaces, and as a flux in metal-smelting. Used also in the manufacture of whiting, and in the preparation of magnesian salts, in lieu of magnesite.

FLINT: As pebbles for tube-mills, used in ore reduction.

FELDSPAR: Used in the manufacture of cement, pottery, brick, tile, and enameled ware, porcelain, glass, artificial stone, chicken grits, in some soap, and as an abrasive.

FLUORSPAR: In cement, glass, porcelain, enamels, and sanitary ware; in steel and iron production as a flux; in the production of aluminum, and in the manufacture of hydrofluoric acid.

FULLER'S EARTH: Used in fulling wool, and largely in soap and oil-refining, as a bleaching, filtering, clarifying, and deodorizing agent.

GARNET: For abrasive purposes, and in the making of garnet-paper, a variety of sand-paper.

GRANITE (crushed): In the manufacture of flooring and artificial stone, and in exterior plastering.

GRAPHITE: In electrical appliances, stove-polish, paint, lead-pencils, lubricants, gun-powder, crucibles, in electrotyping, and glazing, and in dusting foundry-molds, and as a filler for dry batteries.

GYPSUM: In the manufacture of cements, plaster, paper, and glass, and extensively as a fertilizer.

INFUSORIAL EARTH: As an absorbent for nitro-glycerine in the manufacture of dynamite; as a non-conductor of heat, electricity, and sound; and largely for packing boilers and steam-pipes; as a fire-proofing material; in the manufacture of refractory brick; in polishing-powders, scouring-soap; for filtration, heat insulation, and refrigeration, and in making sodium silicate.

JASPER: Used as an abrasive, and in the manufacture of cement and concrete, artificial stone, flooring, roofing, and plasters.

KAOLIN (white clay): Used in the manufacture of paint, paper, pottery, porcelain, and soap.

LIMESTONE: Used by paper and sugar-factories, tanneries, smelters, makers of cement, fertilizers, and chemicals, and as an indispensable flux in iron, copper, and lead smelting.

MAGNESITE: In the manufacture of refractory materials, especially of brick for furnace and converter-linings; as an absorbent in dynamite making, as a non-conductor of heat; in the manufacture of paints; as hearths and as flux for furnaces. From the crude magnesite are obtained carbon di-oxide and magnesium sulphate, both useful materials, while the chloride is utilized in the preparation of magnesian or sorel cement.

MANGANESE: In the making of dry batteries, glass, paints, pottery, tile, and brick. Its alloys and compounds are employed in the manufacture of steel.

MICA: In the manufacture of lubricating oil and grease, and in making roofing, wall-paper, rubber, artificial stone, and insulating material.

OCHRE: In the preparation of paints of many colors and shades; in the manufacture of clay wares.

PUMICE: In paints, soap, metal-polish, and scouring-compounds; for structural purposes, sound and fire-proofing; in concrete blocks; and in the lump form, for polishing wood.

QUARTZ: In the manufacture of glass, paint, pottery, scouring, and other soaps, metal-polish, sand-paper, polishing-powder, artificial stone, plastering, and prepared roofing, and as a flux by smelters; as material for the sand-blast; for wood-filler, for filtering, for acid-towers, for the lining of smelting and other furnaces and by foundries. Also extensively used by chemical manufacturers, and in the making of ferro-silicon and laboratory ware.

ROTTEN STONE: As an abrasive.

SLATE: In the manufacture of paint, prepared roofing-paper, and artificial stone, and for insulating.

SOAPSTONE (steatite): In making laundry-tubs, bath-tubs, acid-tanks, fire-backs for stoves, hearth-stones, mantles, sinks, gas-tips, switch-boards, slate-pencils, and in artificial flooring.

TALC: In the paper, paint, and soap trades, chiefly as a filler; in the manufacture of roofing-paper, lubricants, toilet-powders, rubber, and crayons; in sizing, and in bleaching cloth; for the insulating of boilers and pipes, and as a foundry-facing.

Non-Corrosive Iron-Cobalt Alloys

An interesting publication of the Mines Branch of the Canadian Department of Mines deals with experiments conducted by Herbert T. Kalmus and K. B. Blake at Queens University. The experiments were undertaken to determine the effect of the addition of small quantities of cobalt on the atmospheric corrosion of iron and mild steel, particularly of the very pure product from the open-hearth process. The electrolytic theory of corrosion is generally accepted by engineers, yet it has been disappointing also, because of its failure to predict serious corrosion-phenomena, or to offer a remedy. It is common knowledge that two metals when alloyed often present greater resistance to corrosion than either component metal alone. This may be due to the formation of a compound of the two metals, or under special conditions it may be due to the combination of one alloying metal with the impurities of the other, bringing the solution-tension of the resulting compounds into equilibrium. Alloying a second metal with iron or steel may also effect the corrosion of the original iron or steel by increasing or decreasing the amount of occluded hydrogen. Another important effect of introducing a second metal may be to form an oxide by corrosion, so adherent as to form a coating inhibiting further corrosion. The conclusions reached by Messrs. Kalmus and Blake are: that loss of weight through corrosion is a function of time, being less for the longer exposures. The addition of from 0.25 to 3% of copper, nickel, or cobalt to ingot iron (in these cases a sheet-roofing material supplied by the American Rolling Mill Co., of Middletown, Ohio, greatly increases the resistance to corrosion. In general the corrosion of the alloys formed by the addition of 3% of cobalt to American ingot iron is about three fourths as great as that of alloys formed by the addition of only 0.5% cobalt.

As corrosion progresses, all the alloys prepared form self-protective coatings of oxide-films. It is noticeable that in all cases the oxides formed on the alloy with cobalt are darker, denser, and more tenacious than those produced with alloys of copper or nickel. This does not, however, mean that the protective coating with cobalt will in the end prove most durable. Tests are being conducted to determine exactly the comparative values of cobalt, copper, and nickel, by corroding to destruction.

The amount of corrosion varies with the percentage of carbon in the alloy. It appears that moderately high carbon favors resistance, and that carbon remaining constant the resistance of the cobalt alloy surpasses that of the nickel or copper alloys.

Charges of mild steel were made up in a four-ton experimental furnace, so that the alloys thus produced could be rolled into full-size roofing-sheets for subjection to corrosion-tests. The sheets are 30 by 96 in., No. 26 gauge (0.0188 in. thick).

ANALYSES

	Ingot iron	Ingot iron with 1% cobalt	Ingot iron with 0.6% cobalt	Ingot iron with 1% Monel metal
Sulphur	0.026	0.034	0.040	0.025
Phosphorus	0.009	0.006	0.008	0.008
Carbon	0.010	0.015	0.010	0.010
Manganese	0.022	0.017	0.020	0.015
Copper	0.016	0.028	0.024	0.24
Cobalt	....	1.18	0.60	...
Nickel	....	...	...	0.75

These sheets have been corroding since March 1914, and it will take another year for any of them to corrode through to destruction. The loss of weight by the sheets containing cobalt is materially less than by the others. Both the cobalt sheets have formed hard dense protective coatings. The greatest corrosion is shown by the sheet containing neither cobalt nor nickel. Copper has also proved extremely efficient as an alloy-metal for retarding corrosion of the iron.

The Sulphide-Filming Plant at Magma, Arizona

By J. M. Callow

*The process in use in this plant is covered by the Schwarz U. S. patent No. 807,501, which is the first disclosure of the use of a soluble sulphide for converting an oxide of a metal into a superficial sulphide, and afterward recovering it by a flotation process.

Our earliest experiments were made with H_2S gas as the filming agent. A plant of 25 tons daily capacity was built. In this the gas was applied to the pulp by introducing it into the bottom of an open tank, having a mixing-agitator. The results were encouraging, but the consumption of gas was prohibitive—as much as 8 or 10 lb. per ton. The ore treated was the tailing of the Magma sulphide mill, which at that time carried considerable oxides. Occasional recoveries of 60% (of the total copper) were made, but the results were erratic owing to the difficulty of getting uniform filming of the pulp. Then followed an interval of several months when we used sodium sulphide, calcium sulphide, and calcium sulph-hydrate, in an endeavor to avoid the use of gas, on the assumption that it was objectionable owing to the danger of its poisoning the surrounding atmosphere. This was true when attempting to use it in an open tank. During this time a number of theories were advanced and abandoned. One of these was that natural and artificial sulphides could not be floated together, and that H_2S interfered with the flotation of the natural sulphides. Our experience now is that H_2S, in the proper quantity, really promotes flotation of natural sulphides in company with the filmed oxides, and also that it is immaterial whether the oiling is done before or after filming. Whichever plan is followed is merely a matter of convenience.

In treating sulphide tailing, in which the principal losses were sulphides, the introduction of the gas not only filmed the oxides present, a goodly percentage of which was recovered, but it also raised an entirely new crop of refractory sulphides. An all-sulphide sample of regular Magma ore was tested with and without H_2S. The results are given in Table 1.

The mill-plant was shut-down and we again reverted to laboratory work, which resulted in our adherence to H_2S in preference to any other agent on this particular ore, and also to a complete change in our method of applying it. The plant was re-constructed, crushing machinery and additional cells being added in accordance with the flow-sheet shown in Fig. 1, for the purpose of treating Magma oxidized ores on a commercial scale.

The gasing method used at present introduces the gas into the suction of a centrifugal pump in the manner indicated in the flow-sheet. This has proved effective, greatly reducing the consumption of gas, giving more uniform recoveries, and has removed all danger from the poisoning of the atmosphere; in fact, the commercial results now being obtained date from the first use of this expedient.

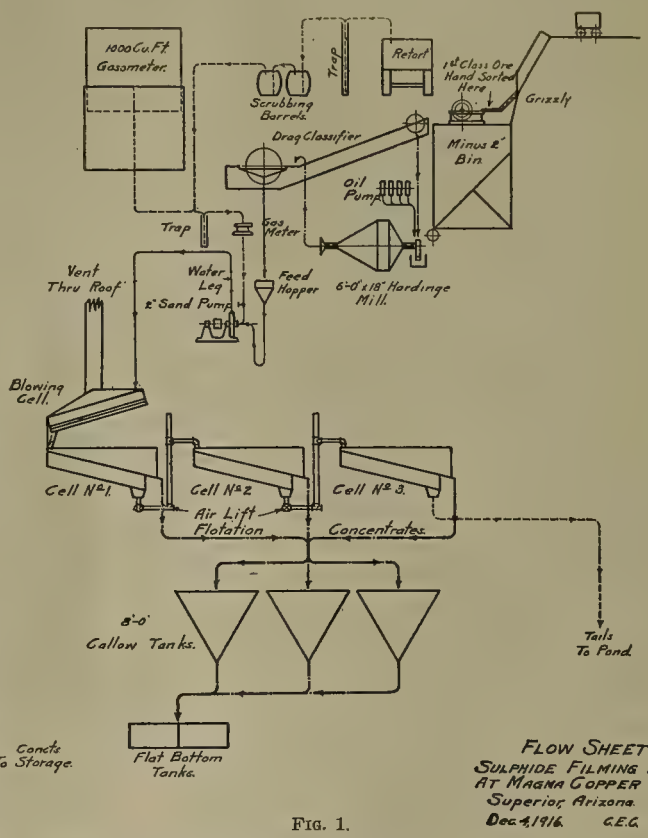


FIG. 1.

The present method of making H_2S gas is to heat sulphur and oil in a retort. Various proportions of sulphur and oil have been tried, our present proportions being 1 of sulphur to 2½ of oil. The temperature in the retort is kept uniformly at 300° C. At times the making of gas has given trouble, owing to changes in the quality of the oil used. Satisfactory results have been obtained at all times with Californian crude oil, but Texan oil al-

*Excerpt from 'Notes on Flotation—1916,' a paper read at the New York meeting (Feb. 1917) of the American Institute of Mining Engineers.

TABLE 2

Test No.	Heads	Tails	Concentrates		Tonnage Oils, Per Cent. Weight							Retort Mixture		Remarks on Gas, Etc.
			Rougher	Cleaner	Recovery[1]	Rate	C.T.	C.T.C.	F.O.	P.T.O.	C.P.O.	B	O	
56	1.10	0.64	8.25	12.10	65.0	.....	60	40	..	..	...	23	77	
57	1.32	0.96	3.60	12.00	31.0	.....	60	40	..	..	...	23	77	
62B	1.15	0.88	10.50	14.00	25.0	.....	60	40	..	..	...	23	77	Excessive heat on old gas charge, test 57.
C	1.15	0.69	10.50	14.00	43.0	.....	60	40	..	..	...	23	77	Moderate heat, 1st firing, 0.77 lb. S per ton.
63A	1.40	1.21	11.90	18.30	15.1	.....	60	40	..	..	...	23	77	No gas used.
B	1.40	0.96	12.90	15.10	34.0	.....	60	40	..	..	...	23	77	Same retort as 62C, 2d firing, 0.36 lb. S per ton.
C	0.74	0.58	5.10	8.40	24.4	.....	60	40	..	..	...	23	77	Same retort, 3d firing, poor gas.
64	1.24	0.69	5.40	9.80	50.9	.....	60	40	..	..	...	23	77	Gas from iron matte.
66	0.91	0.63	7.00	8.20	33.2	29.40	60	40	..	..	...	23	77	Gas from iron matte.
67	0.58	0.47	5.00	.....	21.0	29.40	60	40	..	..	...	23	77	No gas used.
68	0.83	0.49	6.70	12.50	44.2	31.20	60	40	..	..	...	23	77	Slow continuous firing, trying effect of oils.
69	1.16	0.83	12.20	.....	30.9	.....	..	40	60	..	...	23	77	Slow continuous firing, trying effect of oils.
70A	0.94	0.34	7.90	15.10	67.1	28.80	55	36	..	9	...	23	77	Slow continuous firing, trying effect of oils.
B	0.66	0.37	5.00	15.70	58.1	21.60	60	40	..	..	...	23	77	Slow continuous firing, trying effect of oils.
71B	0.91	0.44	7.90	15.70	54.5	34.00	55	36	..	9	...	23	77	Slow continuous firing, trying effect of oils.
72	1.08	0.47	7.20	11.50	60.5	16.50	..	..	..	..	100	23	77	Slow continuous firing, trying effect of oils.
73	0.88	0.44	7.40	17.10	53.3	27.20	55	36	..	9	...	23	77	Slow continuous firing, trying effect of oils.
74	0.86	0.49	7.70	.....	45.8	17.30	60	40	..	..	...	23	77	To try out different oil mixtures.[3]
75A	0.76	0.38	3.80	8.80	55.6	31.20	32	20	..	25	25	23	77	To try out different oil mixtures.
75B	0.76	0.31	3.50	12.30	65.8	31.20	30	45	10	25	...	23	77	To try out different oil mixtures.
75C	0.76	0.38	7.40	.....	52.5	31.20	30	00	25	25	...	23	77	To try out different oil mixtures.
76	0.80	0.47	4.10	17.20	46.6	31.20	30	45	..	25	...	23	77	Trouble with gas.
77	0.69	0.29	3.80	12.00	62.6	24.15	30	45	..	25	...	23	77	Repetition under better conditions.
78[2]	1.00	0.35	4.85	14.80	70.1	29.30	30	45	..	25	...	23	77	Repetition under better conditions.
79	1.23	0.42	7.40	11.25	69.9	30.90	30	45	..	25	...	23	77	Repetition under better conditions.
80	1.01	0.49	4.85	12.90	57.3	27.30	..	..	..	..	...	..	..	But with overheated gas.

[1] Based on rougher concentrates only.

[2] Pulp was already oiled and additional oils had very little effect on results.

[3] C.T. = coal tar. C.T.C. = coal-tar creosote. F.O. = fuel oil. P.T.O. = pine tar oil. C.P.O. = crude pine oil.

ways gives trouble, making a gas containing what we believe to be hydrogen persulphide, which interferes with flotation, and can always be identified by its eye-burning properties. This is in a measure overcome by careful scrubbing, sulphur being precipitated in the scrubbers with free H_2S liberated.

TABLE 1. EFFECT OF H_2S ON NATURAL SULPHIDES

MAGMA SULPHIDE ORE

No H_2S gas	Heading	Tailing	Concentrate	Recovery
Test 1	2.45	0.22	11.82	92.70
Test 2	2.45	0.25	9.62	92.20
Average	2.45	0.235	10.72	92.45
With H_2S gas in excess				
Test 1	2.45	0.28	9.40	91.30
Test 2	2.45	0.20	8.41	94.10
Average	2.45	0.24	8.90	92.70

The Californian crude oil has the following fractional analysis:

Specific gravity, 0.9311 or 20.36 B. at 15° C.
Flash point (open dish), 108° C.
Fractionation:

Temperatures, °C.	Distillate, cc.
100–150	1.2
150–175	1.6
175–200	3.6
200–225	9.6
225–250	22.0
250–275	30.8
275–300	25.2

Free gas in a pulp is fatal to flotation, hence the use of the blowing-cell at the head of the first flotation-cell.

TABLE 4

Date	Test No.	Tonnage Rate	Heads	Tails	Concentrates	Ratio	Recovery
July 8	150	35 00	2.78	0 86	9.50	4.50	75 94
July 9	151	30.00	3 15	1.06	9.72	4.18	74 31
July 12	154	26.00	2.92	1.17	7.02	3.34	72 00
July 13	155	30.00	3.24	1.22	11.66	5.16	69 72
July 14	156	33 00	2.92	1.35	10.26	5.67	61 94
July 15	157	.....	2.92	1.08	8.21	3.89	72 27
July 16.	158	28.00	2.75	0.83	8.30	4 14	77 25
July 18	159	30.00	2.99	0.70	8.32	3.32	83 78
July 20	161	30.00	3.08	1.08	9.18	4.05	73 62
July 23	164	31.00	3.92	1.62	10.80	3.95	69 76
Average	....	30 33	3.06	1.09	9.34	4.22	73.08

NOTE.—Best results in July tests were obtained with a consumption of about 4 lb. sulphur and 10 lb. fuel oil per ton feed.

Date	Test No.	Tonnage Rate	Heads	Tails	Concentrates	Ratio	Recovery
Aug. 9	175	25.0	3.04	0.71	14.85	5.41	80.49
Aug. 10	176	30.0	3.63	0.81	16.07	5.40	81 82
Aug. 11.	177	27.0	5.46	1.25	17.36	3.82	83.22
Aug. 12	178	25.0	5 46	1 8?	22.74	5.72	72.81
Aug. 13	179	27.0	5.12	1 43	16.80	4.17	78.68
Aug. 14	180	25.0	5.04	1.85	16.91	4.72	71.09
Aug. 17	181	25 0	4.23	1.62	18.48	6.46	67.64
Aug. 18.	182	25.0	11.66	2.65	26.50	2.65	85.76
Aug. 19	183	25.0	6.73	2.67	22.26	4.82	68.62
Aug. 20	184	25.0	8.35	2.45	20.67	3.09	80.12
Average	...	25.9	5.87	1.72 ?	19.26	4.63	77.025

NOTE.—Sulphur consumption on tests 181, 2, 3, 4 was 6 lb. per ton. In the other August tests, a minimum of 2.25 and maximum of 3 lb. per ton.

Date	Test No.	Tonnage Rate	Heads	Tails	Concentrates	Ratio	Recovery
Sept. 25	185	28	4 90	1.33	14.8	3.77	80.0
Sept. 27	186	27	5.50	0.79	17.8	3.61	90.0
Sept. 28	187	30	5.00	1.50	18.1	4.74	76.4
Sept. 29	188	25	3.10	0.61	13 9	5 30	84.7
Sept. 30.	189	24	2.80	0.54	13.2	5.60	84.1
Oct. 1.	190	23	2 30	0 58	15.1	8 40	77.8
Oct. 2.	191	24	2.40	0.68	14 4	8.00	75 0
Oct. 3.	192	27	2 60	0 41	14.3	6.30	86 0
Oct. 3	192	27	2.70	0.36	14.9	6.20	89.2
Oct. 4.	193		3.60	0.61	10.3	3.60	89.6
Average	....	26	3.49	0 74	14.68	5.55	83.28

NOTE.—The September and October results were obtained with a sulphur consumption of 2.8 minimum and 3.5 maximum per ton.

TABLE 5

Description	Oct. 14 to 27, 1916				Nov. 1 to 10, 1916			
	Tons	Assay, Per Cent. Cu	Contents	Recovery on O.F.	Tons	Assay, Per Cent. Cu	Contents	Recovery on O.F.
Crude ore received for period	173.300	5.61	972.0	100.0	193.10	5.19	1,002	100.0
High-grade sorted out	3.772	22.70	85.6	8.8	10.08	26.35	289	28.9
Mill feed	169.528	5.22	886.4	91.2	182.12	3.91	713	71.1
Mill concentrates	31.300	16.00	592.0	60.9	25.30	18.70	474	47.4
Mill tails	138.228	2.14	294.4	30.3	156.82	1.52	239	23.7
Sum of high-grade and concentrates	35.072	19.30	677.6	69.7	36.28	21.06	763	76.3
Mill ratio	5.4 to 1				5.02 to 1			
Mill recovery	66.5 per cent.				66.5 per cent.			
Sulphur consumption per ton crude	4.66 lb. per ton. High consumption due to faulty oil used. Figure therefore of little value.				2.06 lb., including all line losses and leaks.			
Oil consumption per ton crude					5.2 lb.			
Flotation oils used	Coal tar ..... 30 per cent. Coal-tar creosote ..... 30 per cent.				Coal tar Coal-tar creosote			
Composition of heads	G.N.S. No. 17 Carbonate ..... 1.01 Silicate ..... 0.89 Sulphide ..... 3.33 Total Cu 5.22				Pensacola, No. 400. Carbonate ..... 2.110 Silicate ..... 0.865 Sulphide ..... 1.490 Total 4.460 (3.91)			
Approximate screen analysis of crushing	+150 = 13.6 per cent. −150 = 86.4 per cent.							

NOTE.—No tables were used in this flow sheet. The results would have been improved if there had been.

Experiments indicate that heating the pulp slightly before gasing is beneficial.

The cost of manufacturing the gas by this method will, of course, vary greatly according to local conditions. Those at Magma are abnormal. Sulphur is costing nearly 3c. today, and oil nearly 1c. per pound, f.o.b. Superior, and costs on a basis of 30 tons per day, and maximum of 3 lb. per ton, stand as follows: 90 lb. of sulphur at 2.74c., $2.51; 225 lb. of oil at 0.914c., $2.16; total, $4.77 = 15.25c. per ton, or approximately 5c. per ton for each pound of sulphur per ton required by the ore.

On Magma sulphide tailing, the consumption of gas varies from ½ to 1½ lb. sulphur per ton. On strictly carbonate ore, assaying 3 or 4% copper, 3 lb. is an average figure, and on the latest test with a mixed carbonate and silicate ore, assaying from 4 to 5% copper, 2 lb. of sulphur per ton. The fuel required for heating the retort is almost negligible. There are no figures for cost since so far we have been burning scrap-lumber left over from construction. The labor item is unduly heavy because the retort is situated some 600 ft. away, and one man has to be held in reserve for the purpose. He could as easily make gas on one shift for 500 tons per day. With sulphur and oil at moderate prices on a 500-ton scale, using 2 lb. of sulphur per ton, my estimate of the total gas-cost is as follows:

1000 lb. sulphur at $45 per ton = 2.25c. per lb.	$22.50
2500 lb. oil at $1.75 per barrel = 0.436c. per lb.	11.00
1 man at $4	4.00
Extra fuel for heating retort and sundry repairs	2.50
Per day	$40.00

Thus the probable cost is 8c. per ton of ore, or 4c. per ton for each pound of sulphur required for the ore.

Other methods were tried—one using powdered coal in a separate retort instead of the oil-mixture, and another in which the oil instead of being mixed with the sulphur was dripped into the sulphur-retort with a force-feed lubricator. The usual iron matte and sulphuric acid method was also tried but none of these methods had anything to recommend them. Iron matte was never seriously considered on account of the recent high price of acid.

The flow-sheet given in Fig. 1 is self-explanatory: The 6-ft. by 18-in. Hardinge ball-mill has a capacity of 35 tons per day when loaded with balls requiring 35 hp., or 45 tons per day when loaded up to 50 hp. requirements and grinding 83% through 150 mesh.

The power requirements are distributed as follows:

1	6 ft. by 16-in. Hardinge ball-mill	35 hp.
1	8-ft. by 14¾ Root blower, No. 1 (400 cu. ft. at 5 lb.)	20 hp.
1	7 by 14 Dodge crusher (1 shift only)	
1	2-in. centrifugal gasing pump	
1	4-ft. diaphragm pump	
1	10-in. belt-drag classifier	
1	Oil-feeder	
1	Ore-feeder	
		55 hp.

This is the equivalent of 37.6 hp.-hr. per ton = 28 kw.-hr. per ton.

The plant is operated by four men for the three shifts, the extra man on day-shift crushing the ore and hand-sorting any first-class ore.

Table 2 gives the results of gasing the sulphide mill-tailing, the feed in all these experiments being that given to the lower or 'gleaner' cells, as they are described on the flow-sheet. The soluble copper in these tests varied from 0.3 to 0.45% and the average for the entire period was 0.35%. Attention is directed to tests No. 63A and 67, showing results on this feed without gasing; further comparisons of more direct kind are given in Table 3.

The results on strictly carbonate ore are given in Table 4, and on a mixed carbonate-silicate-sulphide ore in

TABLE 3. EFFECT OF H_2S ON MINED SULPHIDES AND OXIDES IN MAGMA SULPHIDE TAILING

No H_2S	Heading	Tailing	Concentrate	Recovery
Test 1	0.86	0.67	9.86	23.70
Test 2	0.78	0.60	9.63	24.70
Average	0.82	0.635	9.74	24.20
With H_2S				
Test 1	0.81	0.30	5.05	67.11
Test 2	0.78	0.29	5.51	66.38
Average	0.79	0.295	5.28	66.24

Table 5. The latter tabulation gives a complete record, and shows the contribution that hand-sorting makes to the total recovery. The carbonate results, for the most part, were on the rejections from the hand-sorting done at the mine, but in all these results the headings, referred to, are actual mill-feeds, and the effect of hand-sorting is, therefore, not shown. On the mixed ore, gravity-tables on the flotation-tailing would have added considerably to the total recovery, but on the straight carbonate ores they would have served no purpose.

While on carbonate ores the results may be considered very satisfactory, there is still considerable work to be done on the mixed ores. Several points are still obscure, which will take time, further experimenting and research to overcome. These are: (*a*) Uniform quality of gas, and what are the interfering elements in poor gas? (*b*) Why are silicates and the coarser sizes of carbonate mineral more difficult to film than fine carbonates?

The present results are encouraging, and positive enough to lead us to believe that in due time all such ores as these will be as successfully treated by this process. As to the treatment of oxidized ores other than copper, so far we have not been able to film zinc carbonates at all but lead carbonates are comparatively easy. We have had no success with gas on these, but sodium sulphide gives excellent results. The following figures are the average of 13 different experimental runs made, treating a lead-carbonate tailing-dump at the Prince Consolidated, Pioche, Nevada: heading, 6.97%; tailing, 1.85%; concentrate, 38.81%; ratio, 7.21:1; recovery, 77.28%.

Graphite at Llano, Texas

*The older schists and gneisses of Burnet and Llano counties, Texas, contain promising deposits of flake graphite. Two mills have been built and put in operation, that of the Texas Graphite Co., nine miles west of Burnet, and the Heath, five miles north-east of Llano. The Heath was operated as a gold mine for a short time, but Llano County gold mines have not been remarkable for profits obtained.

Many years ago I made reports on the graphite deposits in Clay county, Alabama. Later, Ernst Prochaska built and operated a mill for Paul Gilardoni, of Birmingham, and produced an excellent quality of flake graphite. It is an interesting contribution to present-day flotation methods to know that Mr. Prochaska "floated" his concentrates with lubricating oil. This was 23 years ago, or about the time that Carrie Everson was "floating" ore concentrates with oil in Colorado. Mr. Prochaska was probably the first in this country to use flotation methods in concentrating graphite. He used an ordinary lubricating oil.

The graphite deposits in Burnet and Llano counties are remarkable for the excellent character of the flake graphite held in the schist. There is but little black mica present, so that this bane of the graphite miner is not a factor in concentration. The gangue is highly silicious, with soda feldspar as the chief additional constituent. The content of the schists in flake graphite varies from 8 to 10% mill run, with occasional masses of much higher content. The extent of the deposits is certainly large, far beyond any possibility of exhaustion for many years. Much of the mining is mere quarry work, three miners supplying the mill with 25 tons of crude material per day of 24 hours. The following estimate gives a close approximation to the cost of operating a 25-ton mill per day of 24 hours:

Superintendent	$4.93	
Chemist and bookkeeper	2.96	
Two drivers	5.26	
Ten mill-men	25.00	
Two trammers	4.00	
Two hoist-men	5.00	
Two carpenters	7.00	
Eight muckers	16.00	
Three miners	7.50	
One pump-man	2.00	
One blacksmith	3.00	
One electrician	3.50	
One pipe-line man	2.50	
		$88.65
75 gallons of oil at 3 cents, for the oil engine		2.25
4 gallons of lubricating oil at 32 cents		1.28
2 cords of wood for one of the boilers		3.00
		$95.18

Allow $4.82 additional for unforeseen emergencies, and the total daily cost will be $100, or $4 per ton of crude material. The $4.82 additional will take care of power, repairs, wear and tear, water, etc. This plant was making a concentrate containing not less than 50% of graphite carbon, as flake graphite, and was meeting a contract obligation for graphite of that quality. It produced 350 pounds of this concentrate from a ton of crude material selling for 3 cents per pound f.o.b. railroad cars. The value of the concentrate from a ton of crude material was therefore $10.50; the cost of mining and treatment, as per the above items, was $4. Laboratory experiments on a considerable scale have shown that this concentrate can be re-ground and re-concentrated and the content of flake graphite brought up to 87%.

There is opportunity in Burnet and Llano counties for a considerable graphite industry. The product would be flake, or crystalline graphite, always easily marketed.

*Abstract from article by W. B. Phillips, *Manufacturers Record*.

The Miami Appeal—II

In our issue of February 3 we reproduced part of the defendant's brief before the U. S. Circuit Court of Appeals at Philadelphia. Herewith we give two extracts from plaintiff's oral argument, as made by Mr. W. Houston Kenyon. We quote verbatim.

Mr. Scott classifies these surface-tension processes off by themselves. He has a heading, "Surface tension flotation."

"Surface tension flotation is also known as film flotation or skin flotation. This form of flotation has never been widely adopted, but some understanding of it is necessary in connection with a comprehensive explanation of the subject of flotation generally."

It is what we describe as the greased needle effect, and at the bottom:

"In surface tension or skin flotation the floating layer is substantially only one particle thick."

That is all you can get, just one particle thick. The amount of matter that can be floated by surface tension is so minute. Here Mr. Scott says it is a characteristic of this process, that the floating layer is only one particle thick, and the amount of matter that can be floated in that way is so minute as to render any flotation process based on this phenomenon of little or no value, owing to the immense water surfaces that would be necessary in order to float any considerable amount of mineral.

Then he quotes evidence to that effect. There can be no sort of question that that is a fact as to the mode of procedure, the mode of working out of that bubbles machine, and there can be no possible sort of question but that that was the purpose and intention of the bubbles patentees in the matter of those machines of Fig. 1, 2, and 3.

THE COURT (Buffington, C. J.): What do you conclude from all of that?

MR. KENYON: That that process does not justify the defendant's process, which defendant's process is not a skin flotation process, but like ours—a froth.

THE COURT (Buffington, C. J.): In other words, that it does not anticipate the patent?

MR. KENYON: And it does not justify the defendant—

THE COURT (Buffington, C. J.): Of course it does not justify them if it does not anticipate the patent.

MR. KENYON: It does not take the defendant outside of the construction and scope of the patent. It has no effect at all to limit the scope of the patent in suit, first, because the amount of oil, the critical amount of oil which we disclose, and which is the kernel of our step in advance, and which the defendant employs, is not disclosed and secondly because it is not a froth flotation process at all.

THE COURT (Buffington, C. J.): It shows the method by which they use air in this treatment, and how they use it in their treatment.

MR. KENYON: Yes. It shows an attempt to utilize the buoyancy of air bubbles in the concentration of ore, and it failed, the evidence is complete to that effect in the record, and why did it fail? It failed because its fundamental conception was that the use of air should be limited to a skin flotation process. The air bubbles merely bring the metal particles to the surface and have no further function—drop them there. And secondly, it fails in that it discloses no conception that by using this minimum amount of oil, this one-tenth of one per cent, you would get a bubble which would not let go of the metal particle and burst when it got to the surface, but you would get a bubble so persistent that it would hang onto the metal particle and other bubbles coming up would hang onto other metal particles and so they would build up a froth which would lift the metal particles above the surface of the water, carry them in what the patent calls a froth, an accumulation of bubbles, and in any way deliver them over the lip or the dam for the purpose of ore concentration.

Now the patentees of the first patent in suit took that step in arriving at their process; they conceived, or let us say, walked with their eyes shut upon (because I believe that was the literal fact)—walked with their eyes shut upon—the phenomena that with the ore pulp and the agitation which they were using to send the metal down, but with that minute proportion of oil, instead of going down it came up in a copious froth and carried the metal with it up to the surface, and through and out of and above the surface and into a froth that was fitted to become the carrier and conveyor of that value so that it could be separated out.

THE COURT (Buffington, C. J.): The froth obtained in a particular way?

MR. KENYON: A particular way.

THE COURT (Buffington, C. J.): By beating in the air?

MR. KENYON: No, not by beating in the air.

THE COURT (Buffington, C. J.): Then how is this froth obtained or introduced? By beating in the air?

MR. KENYON: It is obtained by the presence in the ore pulp of that kind of a bubble which is produced by modified ore pulp, ore pulp with this minute quantity of oil in it, and the collision—

THE COURT (Buffington, C. J.): What is bothering me is—do you get the same kind of froth these defendants do?

MR. KENYON: Absolutely.

THE COURT (Buffington, C. J.): Why is it, then, that their froth subsides and yours does not?

MR. KENYON: That is simply a question of degree—that is simply because they have super-saturated it with

air. Theirs, you can see, is a thinner froth than ours. More air, less metal.

THE COURT (Buffington, C. J.): You mean they have got more agitation?

MR. KENYON: No. I should say we—

THE COURT (Buffington, C. J.): How do they supercharge it with air?

MR. KENYON: By blowing in endless quantities of air at the bottom.

THE COURT (Buffington, C. J.): Then they are blowing in that air by compressed air more violent than your method of agitation. Is that it?

MR. KENYON: I should not say that. I should say they introduced more air in there. I should say it was perhaps one hundred times—I don't know—

THE COURT (Buffington, C. J.): If it gets more air, and it can be done instantaneously, why, then, do you have to do it from two and a half to ten minutes?

MR. KENYON: I think we have to do it from two and a half to ten minutes simply because the Gabbett cone is such an inefficient way of getting air in, your Honor.

THE COURT (Buffington, C. J.): In other words, this method of introducing air from below is better than your method?

MR. KENYON: That is, in and of itself, as a method of introducing air, for the purposes of our process, it is an improvement.

THE COURT (Buffington, C. J.): Now, if they have a better method of the introducing of air, what have you to say about the construction of these claims, when you withdrew the first claim, and were precluded from getting all the claims. That is what I want to get down to.

MR. KENYON: Let me go right to that. What was that claim? It was for the use of these critical proportions of oil—this critical proportion of oil—in an ore pulp, and thereby effecting concentration, whether by skin flotation, or whether by froth procedure, or whether by sinking. There was no limitation in that claim to froth or to any way of getting froth, but simply to the bald, broad combination in any process of an ore pulp and that minute proportion of oil, and the result, ore concentration.

Now, what did they reject that on?

THE COURT (Buffington, C. J.): I do not care what they rejected it on.

MR. KENYON: It is important.

THE COURT (Buffington, C. J.): What did the claim mean? No matter whether they, in rejecting it, did make a mistake. It was abandoned by the patentees.

MR. KENYON: Yes. That is, we abandoned any claim to this minute proportion of oil in an ore pulp *per se*, regardless of what it did and we limited ourselves to the combination of that critical proportion of oil in an ore pulp and agitation and a froth. Those are the only two things that were added, and the froth as the result of such agitation as brings the air particles and the oiled metal particles in contact, whereupon they rise by the laws of nature. An accumulation—

THE COURT (Buffington, C. J.): Then, you come down to those two elements. Now, the Supreme Court has said that you got that agitation by a method which they found very original?

MR. KENYON: Yes.

THE COURT (Buffington, C. J.): And you get a certain kind of froth?

MR. KENYON: Yes.

THE COURT (Buffington, C. J.): Then, you have got here to meet another method of agitation, to wit, by air from down below.

MR. KENYON: Yes.

THE COURT (Buffington, C. J.): You have got to meet a different kind of froth?

MR. KENYON: Let us say agitation by aeration.

THE COURT (Buffington, C. J.): By what?

MR. KENYON: By aeration. Agitation by aeration, that is by introducing air—by aeration.

THE COURT (Buffington, C. J.): You have got it by the compressed air coming in?

MR. KENYON: Yes.

THE COURT (Buffington, C. J.): Is that within the terms of your claim as the Supreme Court has construed the patent?

MR. KENYON: I believe it is, although the Supreme Court had no such question before it. My whole argument is just going to lead right along that line, and I have a great many facts to present to you that bear this way and that way on that. But the defendant has departed from this process of the prior art (by which it justifies), by the utilization of air, of a bubble, of a different character, the sort of air bubble that forms in a modified pulp, and the evidence is clear that that sort of air bubble is different in character, so different that when it gets out of the water it persists. There is the secret of this froth process. And the defendant utilizes these peculiar bubbles as a *froth-forming instrumentality*, which carried the metal particles up *through* the water surface and, by reason of the persistency and coherency imparted by the oil in the critical proportions, sustains them there above the water surface in and as a metal-bearing froth and so separates the metal from the gangue. The defendant takes from this bubbles patent only the way in which it introduces the air, namely, from the bottom.

Now, I shall in a moment present the complete equivalency of those two ways of introducing air, but first let me show that what the defendant has done satisfies the claims of the patent in suit, so far as words go, for no particular kind of agitation is recited in these claims, and no particular kind of froth, simply agitation, simply froth, and we do not have to argue about the fact that both those things exist there, however produced: and it satisfies the specifications—it satisfies the specifications, where two examples are shown, and the last one never called to the Supreme Court's attention, because they were not construing the patent. The first patent in suit illustrates the invention by two examples, the first the revolving cone mixer with baffles, and the second, the agitation of rising bubbles on relief of pressure.

Socketing Wire-Rope

Miners are sometimes at a loss to find what they consider a good way to secure the end of a hoisting-rope in the socket to which the hook is to be attached. In one of the wire-rope catalogues of the John A. Roebling's Sons Company is illustrated and described a method of doing this that has been found to give satisfactory results. It is here reproduced:

DIRECTIONS FOR SOCKETING A HOISTING-ROPE. (Follow the illustrations).

1. Measure from end of rope a length equal to basket of socket. Serve at this point with not less than three wraps. Cut out hemp centre—open strands.

2. Separate wires in strands, straighten by means of iron pipe, cleanse with kerosene oil, wipe dry.

3. Dip wires into one-half muriatic acid, one-half water (use no stronger solution). Keep wires in long enough to be thoroughly cleansed—wipe dry. Serve end that socket may slip over all of wires.

4. After placing on socket, cut serving wire at top—have all wires evenly distributed and even with top of basket—place fire-clay around bottom of socket.

5. Pour in molten pure zinc—do not use babbitt.

6. Remove all servings except one nearest socket. After cooling it is ready for service.

PROPER METHOD FOR SOCKETING A HOISTING-ROPE.

Mining in Utah

By L. O. Howard

Weather conditions continue to interfere with mining operations in various parts of the State. While the intense cold no longer prevails, a succession of snowstorms, high winds, and thaws has added further difficulties to a season that has been unusually rigorous, even in the most favored districts. Tintic was cut off several days from the smelters through blockades on the railroads caused by snow-slides late in February. Some damage was reported in the district itself, where other slides destroyed buildings and equipment. Park City was likewise cut off for a short time. The persistent shortage of coal reached alarming proportions in both districts, some curtailment of mining being caused thereby. The congestion of railroad traffic has also hampered the endeavors of the smaller operators to get their ore to market, and to obtain sorely needed supplies. Operations in the open pits at Bingham have been conducted under difficulties. The coal shortage was also felt here by some companies, and many individuals resorted to the parcel-post as a means of obtaining fuel.

In Little Cottonwood the South Hecla and Michigan-Utah continue to make heavy shipments. From the first of the year to the middle of February the latter had

shipped about 1000 tons of ore and had a further 800 tons at its tramway-terminal awaiting haulage to the railroad. The usual spring rumors of consolidations are being circulated. The most pretentious is the suggested consolidation of the South Hecla, Albion, Alta-Germania, South Hecla Extension, Alta-Michigan, Secret, Sells, and Peruvian mines, all situated on the south side of Little Cottonwood canyon, and extending into American Fork canyon. No official statement has been made public.

Dividends for the first six weeks of this year aggregate $715,400, paid by six companies, three in the Tintic district, the Chief Con., Dragon Con. and Iron Blossom; the Moscow in Beaver county; the Silver King Coalition at Park City; and the Utah Metal & Tunnel at Bingham. This by no means represents the earnings available for distribution as many of the larger companies do not declare dividends until later in the quarter, notably Utah Copper, which makes payments at the present time as large as the rest combined.

Since the beginning of the year the Ohio Copper Co. has been operating its mine at Bingham on company account, under the same resident management that directed the work previous to the recent troubles and receiverships, emerging finally out of the hands of various committees of bondholders into the control of the stockholders. The mill is treating 2500 tons daily, but is said to be making only a 50% recovery for a monthly profit of $30,000. There is a large tonnage of ore containing 0.9% copper available for treatment. A small test-plant is to be equipped with Janney and Minerals Separation flotation-machines, in an endeavor to increase the recovery. If the metallurgical problems can be solved there is reason to believe that Ohio Copper will yet justify early hopes.

Development of the oil-shale beds, to which reference was made in my last article, is threatened with extinction through the recent withdrawal order of the Federal Government which reserves thousands of acres of these shales for the use of the Navy.

The approaching completion of the Deep Creek railroad is stimulating activity in the Clifton and adjoining districts. It is said that much ore awaits shipment, claims are frequently changing hands, new townsites being laid out, new companies incorporated, and the district being given every opportunity to justify the claims of its sponsors, many of whom are among the most solid men of the State. The region has had the benefit of more competent examination and direction of affairs at the hands of capable engineers than any other, and so far is remarkably free from ill-considered flotations, both of which facts are greatly in its favor and lead to the expectation that it will reward the hopes of its friends.

The unusual profits of the metal mines and the aggravated coal-shortage have aroused a sentiment that is finding expression in the introduction of numerous radical and detrimental bills in the present session of the legislature. Most of the bills for taxation and regulation find a ready mark in the mining companies, and in many cases are apparently aimed at them. Income-tax bills, mine-tax bills, compensation bills, land-board investigations, etc., all threaten to hit the mines seriously. First came a State income-tax bill that followed the schedule of the Federal law, but was finally reduced one-half throughout. As passed unanimously by the House it provides a tax of 1% on the total net income of corporations and a special tax of 50 cents for each $1000 of fair valuation of its capital stock in excess of $99,000. This bill, which adds taxes in addition to all the usual levies, is regarded as unnecessary and detrimental to the best interests of the State. There is no acknowledgment of the wasting assets of mines, making the bill peculiarly discriminatory. The bill has not yet passed the Senate, and the Governor has emphatically stated that he will veto it if it comes to him for signature. Its fate is therefore uncertain. The House has further passed a resolution calling for a constitutional amendment to provide for the taxation of mines "as other property," in other words, at full cash value, without supplying any machinery for determining that value. The experience of Michigan in taxing mines, even with the assistance of the best advice, is fresh in the memory of mining men. What the result of an attempted appraisal by a non-technical board of equalization, based on reports by equally poorly equipped assessors, will be, can only be left to the imagination.

Two compensation bills have been introduced. One is a very radical measure in the House to which all employers of labor take exception on the ground that it allows the employee to enter civil suit if he desires to waive the legal compensation, while at the same time depriving the employer of the defense of assumption of risk, the fellow-servant rule, etc. The bill introduced in the Senate was drawn by a commission appointed by the Governor two years ago, and embodies the result of a careful study of the laws of other States and the adoption of the best of their provisions. A compromise measure is expected.

The air-tight prohibition bill which goes into effect during the middle of the year is so far the sole contribution of the legislature to the welfare of the mining industry. The PRESS has described briefly the plan of the State Conservation Commission, working in conjunction with the University of Utah, U. S. Bureau of Mines, and American Mining Congress, to promote the mining industry, by aiding the prospector as well as investors in their search for mines. This work is likely to be greatly hampered and one of the most important features abandoned, since it is the general opinion that the Conservation Commission will be allowed to die when the terms of the present members expire shortly. The compilation of the resources of the State by the Commission was having an important effect on prospecting and excellent work was being done, which it is to be feared no other agency will be in a position to do as well.

The old mining districts of Little Cottonwood and American Fork are attracting increasing attention, and it is expected that the new activity will meet success.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

NEW MEXICO

RENEWED ACTIVITY IN THE IRON-MINING REGION.—ZINC MINING ACTIVE.

A RENEWAL OF MINING ACTIVITY IN THE PINOS ALTOS DISTRICT.

At Hanover and Fierro several hundred men are employed by the eight different operating mining companies. It is difficult for a stranger to get accommodations, the hotels and rooming-houses being crowded. It is reported that the U. S. Copper Co. plans to build a large hotel at Hanover this spring. The Santa Fe railroad is doing the biggest business in freight since the line was extended to Fierro.——The Colorado Fuel & Iron Co., which has mined and shipped iron ore for many years from Fierro, is employing 250 men. Ore is being mined from the Jim Fair and Snow Flake cuts at Fierro and from the Cupola property at Hanover. Shipments average 500 tons a day from the mines to the company's reduction works at Pueblo, Colorado. This company has been operating under lease from the Brock, Barringer, and Brockman interests for nearly 20 years, thousands of tons of high-grade iron ore having been shipped from the district.——The Hanover Bessemer Steel & Iron Co. (Brock, Barringer, and Brockman) is a new corporation formed to mine the properties that have been under lease to the C. F. & I. Co. and lately taken over by the new company. The company is operating in the Union Hill cut just above the new mill, and a mile of tramway has been completed from the Continental property adjoining the Union Hill. This tramway is laid along the crest of the ridge and ends at an incline 100 ft. above the mill, the cars being raised and lowered by cable. With the construction work under way and the work in the mines the company has about 200 men on the pay-roll. It is also learned that the Bessemer company will superintend the work at the Jim Fair, Snow Flake, and Cupola properties after June 1. An agreement has been reached with the C. F. & I. Co., the present lessees, to give up its lease and suspend operations at that time. The agreement provides for the contracting of all iron concentrate from the mill to the Colorado people. The new Bessemer plant is well under way, one unit of 400 tons capacity daily to be completed and ready for operation by May 1. All concrete foundations are in and the greater part of the frame work is up, and installation of machinery is progressing. The remainder of the equipment is arriving. Manager B. E. McKechnie says they will use the wet magnetic separators in handling their ores. The crusher-room will contain a 7½-inch gyratory crusher and two sets of rolls, Traylor type. The ore will be transferred by belt-conveyor to bins in the main mill and fed to ball-mills and crushed to 60 to 80-mesh. The ore then goes to the wet magnetic separators. Two crude-oil engines of the La Vergne type have been received. The mill-site is on the line of the Santa Fe railroad, on the Union Hill property midway between Hanover and Fierro.

The A. R. Davidson property north of the Jim Fair cut has produced three cars of 7% copper ore each week for the past two months. The Hanover Copper Co. owns 14 claims northeast of the Philadelphia group of the U. S. Copper Co. at Hanover, and is employing 30 men, mining 20 to 30% zinc carbonate and shipping two cars a week. The deepest pit is 100 ft., but is to be sunk to 300 ft. and then tapped by an adit 1000 ft. long driven in from the south. The equipment consists of an air-compressor operating 8 jack-hammer drills, water Leyner type, and a 15-hp. Fairbanks-Morse gas-engine hoist. This property is owned by G. A. St. Clair of Duluth; his son R. G. St. Clair is in charge.

The Republic Mining & Milling Co., headed by William H. Janney and associates, is another recently organized company. It has acquired the Welch property lying east of the Empire Zinc concentrator at Hanover. Considerable rich zinc ore has been shipped from these properties. Development on an extensive plan is now under way; a new double compartment shaft is already down 150 ft. and will be continued to a much greater depth. Driving, cross-cutting, and blocking out ore to secure tonnage is the aim of the company. It is announced that one of the best metallurgists of the country is identified with the Republic people, who will have charge of the new mill now being planned for. It is also understood that experiments are now being conducted in an effort to evolve a treatment whereby zinc ore as low as 10 and possibly 5% can be treated at a profit. The ore is complex. Present plans call for the completion of a mill within six months.

The Chino Del Norte is yet another new company, with good properties near Fierro. Development is now under way.

The Empire Zinc Company at Hanover is increasing its production steadily, the new concentrator completed last year running full capacity. About 150 men are employed in the mines and mill. Speaking of the company's Cleaveland mill at Pinos Altos, where flotation is being added, Manager Schmidt stated that they are also considering putting in flotation at the Hanover plant. A second oil-engine of 250 hp. for needed power has been ordered and will be installed late in the spring. Shipment of concentrates averages better than 1000 tons a month, the crude ore mined being between 3000 and 3500 tons a month. Besides the mill product the company is making regular shipments of zinc carbonates.

A rich body of ore has been uncovered recently at the Philadelphia property of the United States Copper Co. at Hanover. Five feet of rich copper ore, assaying better than 15%, was cut into on the 70-ft. level at shaft No. 2. Development of this strike is being pushed, the company aim being to exploit different levels in both shafts, besides sinking shaft No. 1 to a depth of 1000 ft. The shafts have been re-timbered where needed and the head-frames put in first-class shape. The power plant is now in operation, as also the large air-compressor. The company expects to be employing a big crew by spring time. New surface improvements are planned for in the way of needed buildings, besides the new hotel planned for the town. While the company owns a sawmill, the recent bad spell of weather has made delivery of lumber slow. But the worst of the winter is over and from now on delay for timber will be a thing of the past. By next winter the company hopes to have conditions so improved that delivery of mining timbers and lumber will be prompt. The mill is of capacity sufficient to supply material to other companies operating in the district, not only Hanover, but at Pinos Altos also.

The future of the Hanover-Fierro district is safely assured. Average daily shipments are 15 cars and sometimes 20. The new companies reaching a producing state guarantee an immense tonnage from this district within the next twelve months.

Mining conditions in the Pinos Altos district are improving. The pay-roll for January was $16,000. This includes the

Empire Zinc Co.'s Cleaveland mine and mill, and the El Paso Mining Co.'s properties and mill. The U. S. Copper Co. started operations last month. There is not an idle man in this camp. The Cleaveland mill of the Empire Zinc Co. is operating three shifts and shipping regularly. The installing of the flotation-plant is proceeding rapidly. The work of overhauling, repairing, and enlarging the El Paso Mining Co.'s mill was completed last week, and the mill is now running three full shifts. The addition of a ball-mill and the flotation process has more than doubled its capacity; it is expected to handle 75 tons per day. Six men are employed on each shift. The C. & O. Mining Co. expects to resume by the first of the month. For several months the company has only kept the mine unwatered. The main shaft is 200 ft. deep. The ore has been developed on the 100 and 200-ft. levels, and there is 70,000 tons of ore blocked out. It is said that the company will mill its ore at the El Paso Co.'s plant. At the Doyle-Clark, or Manhattan mine, development is progressing steadily. Shipments of a good grade of ore are being made from their Indian Hill property, which adjoins the Manhattan on the north-west.——At the Hardscrabble, taken over last December by the United States Copper Co., the first double-compartment vertical shaft is down 33 ft., with the bottom in ore assaying from 2½ to 3% copper and 2 to 3 oz. silver. A second shaft will be started this week 600 ft. north of the first, which is known as the Owl, and the second as the Granite. Both shafts are within 100 ft. and south of the prospect shafts, from which high-grade ore and concentrating ore have been mined and shipped. In both prospect shafts three feet of high-grade copper and silver ore has been uncovered. Two air-compressors, 60 hp. each, have been ordered and are expected within the next 60 days. The compressors will furnish power to run jack-hammer drills, hoists, and pumps. Men are repairing and building roads to the saw-mill 12 miles distant. The roads are in bad condition. The company has contracted with Mexicans to deliver timbers both to the Pinos Altos and the Hanover properties. These Mexicans came from Mexico with Gen. Pershing's column, and have 180 head of stock, with good wagons and harness. The incline shaft of the Calumet-New Mexico Mining Company is down 200 ft. In the north drift, on the 100-ft. level, the face of the drift is in ore assaying 25% zinc, 20% lead, 8 oz. silver, and $4.65 in gold, with a trace of copper. In the drift, on the 200-ft. level they are within 50 ft. of the same vein. Hand-drills are being used. This is not the vein on which the shaft was sunk, the latter being a 4-in. vein of quartz carrying 1.3 oz. gold, 12 oz. silver, 10% lead, 6.7% zinc, and 1% copper. A double-compartment vertical shaft is planned and the company also contemplates the erection of a small milling-plant.

BUTTE, MONTANA

Semi-Annual Meeting, Montana Section, A. I. M. E.

The semi-annual meeting of the Montana Section of the A. I. M. E. was held at the Silver Bow Club on Friday, February 2. An informal dinner was served earlier in the evening to 62 members and guests. Chairman J. L. Bruce called the meeting to order and talked on membership in the Institute, and the activities of the Naval Consulting Board. C. W. Goodale spoke regarding contributions for the relief of Belgian children, with an appeal to the members of the Institute to respond in appreciation of the work of H. C. Hoover.

The following officers were chosen for the year 1917: Chairman, W. C. Siderfin of Butte; vice-chairman, Oscar Rohn of Butte; secretary-treasurer, E. B. Young of Butte; executive committee, C. D. Demond of Anaconda and F. W. Bacorn of Butte.

An interesting paper was read by L. D. Frink, superintendent of the Speculator mine, upon 'Some Applications of Mine Ventilation in Butte.' Several exhibits and photographs showing the operation of the canvas-tubing, added to the value of the talk. Discussion followed by Goodale, Bruce, Dunshee, Bacorn, Warner, and Simons.

F. A. Linforth, of the Anaconda mine geological department, exhibited a number of models and maps to show features in the graphic interpretation of geological problems. Discussion by B. H. Dunshee, of the A. C. M. Co., indorsed the value of such work to the mining department. He also gave an interesting account of his recent trip to the Hawaiian Islands. The secretary reported that the mailing list of the Montana Section now shows 202 names, a gain of 25 in the past year, with 15 applications for membership.

JOPLIN, MISSOURI

Retarded Production Due to a Number of Causes.—Prospecting New Territory Unusually Active.

Never in the history of the district has there been a greater desire to maintain ore production at its maximum, but singularly enough, everything apparently has conspired to prevent this maximum being attained. Continued breakdowns of the electric power company's steam-turbine plants seriously have hindered all of those mines and mills dependent upon this source of power. In addition, with the company's hydro-electric plant not running even at 50% capacity, there has been a lack of rain and snow this season, and this has caused an overloading of the turbine-plants, hence the frequent stoppages of the steam-turbine plants. Anticipating normal conditions, the power company had undertaken to supply a large number of new mines and mills, and this has added to the difficulties of the situation. It has not been possible to replace electric-power plants with steam-power plants, as deliveries of machinery cannot be made under six to ten months, so that producers that are dependent upon electric power hesitate to attempt changing their plants, hoping that a normal condition may again obtain.

Nor have the steam-power plants been without difficulty. Those using gas for fuel have been cut off from the pipe-line owing to a shortage of gas, while those using coal found it difficult to maintain regular shipments and a supply of coal. As a result, even this class of mines is not holding up its production. Winter conditions also have interferred to an unusual degree; many mills have been frozen up from eight to ten days at a time, whenever a blizzard has come to the district.

In spite of these untoward conditions prospecting has been continued throughout the Kansas and Oklahoma fields. Many more acres of ground have been leased during the past month, and the United States is being scoured for prospect drill-rigs of the Keystone type to prospect new territory. Most of the leases are made upon the basis of drilling being started within 30 to 90 days and the difficulty in securing drills is a serious handicap in many instances for lease holders, although the situation now is fairly well understood by the land owners, and restrictions are being removed where cancellations of lease would have resulted. Every freight-train passing through that field is bringing in drill-rigs from all over the country, and the factory orders alone for new machines in that field are enormous. It is estimated that 300 drill-rigs are at work and the lease contracts will require as many more during the next 60 days if the contract obligations are fulfilled. Never before has there been such drilling activity in the history of the zinc-field. The results in the way of development in new territory are remarkable in its extent, and the richest type of ore yet developed in the district is being found. Some of the new mills in the Miami district, which have finally gotten down to a regular production, are actually turning out from 200 to 450 tons of concentrate per week, a record never dreamed of by the most optimistic operator of past years.

Extensions of the drilling are noted south of Galena, Kan-

sas, to the Oklahoma State line, and west of Badger-Peacock for six miles; also south-west of Melrose, Kansas, where the drilling for oil has shown the existence of zinc. Drilling in Kansas, therefore, reaches from the Oklahoma-Kansas State line five miles south-west of Melrose, Kansas, in a line north-east through Columbus and from a short distance east of Weir City, to a point one mile north of Waco, Kansas, on the State line between Missouri and Kansas. Within this three-cornered piece of the State of Kansas is centred 85% of the present drilling activity in the Missouri-Kansas-Oklahoma zinc-field. The remaining field of activity lies east of Waco, on the Missouri side and south of the Kansas line, in Oklahoma, extending from the State line south-west of Miami and south of the Neosho river.

TORONTO, ONTARIO

THE MILLS TO HAVE CYANIDE.—SATISFACTORY DEVELOPMENT OF MCINTYRE.

The production of the Porcupine district is being curtailed by a shortage of skilled labor, the supply of which is inadequate for the constantly increasing requirements of the plants. Another and still more threatening drawback, that for some time has been a cause of anxiety to mine-owners, has fortunately been avoided. Toward the close of 1916 the companies were notified by the Cassel Co. of Glasgow, Scotland, from which they have lately been receiving their cyanide, that they would be unable to continue the supply. However, efforts were made by Canadian representatives in Great Britain to procure a reversal of this decision. Last week the provincial Department of Lands and Mines received a cablegram from R. Reid, the Ontario government agent in London, announcing that the Cassel Co. would continue to furnish cyanide for Canadian mines. The Hollinger Consolidated is badly handicapped by adverse labor conditions. It is employing a force of 800 men, and, if they were obtainable, would take on 500 more. The opinion prevails that the present dividend will be cut in two, or, at all events, be considerably reduced, in anticipation of which the stock has shown a downward tendency, selling as low as $5.09, or about $2 below the high mark of last year. The company, since the merger, has been forced to keep production at a maximum to maintain its regular dividend of $246,000 every four weeks, and the completion of the addition to the mill has been unavoidably delayed. It is considered that with the increasing cost of labor and materials, a continuation of the present dividend would be economically unsound. During January the Dome Mines produced bullion to the amount of $181,000 from the treatment of 89,600 tons of ore, of the average value of $4.57, at an operating cost of $2.81 per ton. With the present advance in the cost of labor and materials, the slight increase in working cost of only 4c. per ton, in comparison with the figures for January 1916, is regarded as a satisfactory showing. The annual statement of the Dome Lake shows the total revenue was $18,663, and expenditures $111,451. Owing to extensive development work, the mill was only operated a short time during the year. The installation of a Hardinge ball-mill will bring the mill capacity up to 200 tons per day.

The McIntyre milled 14,317 tons of $10.60 ore in January and produced bullion to the value of $145,297. The average monthly production during the last quarter of 1916 was $118,764. The new 600-ton mill is running smoothly, though not yet up to full capacity. The management, following the example of the Hollinger and Dome, will hereafter make regular monthly reports of production and tonnage. Stations have been cut in No. 5 shaft at the 700, 800, and 900-ft. levels and cross-cutting is under way. Large orebodies have been opened at the Davidson. The main vein on the 100-ft. level is 55 ft. wide, 5 ft. of which is stated to be high-grade. A separate orebody has been opened at the 200-ft. level, the vein being 35 ft. wide. On the 300-ft. level mineralization extends over a wide area, a cross-cut shows vein-matter for 187 ft., a section of which 5 ft. wide is said to run $50 per ton. At the Schumacher, developments at the 200-ft. level are highly satisfactory. An outcropping vein north of the shaft has been cross-cut for 7 ft. with the face still in ore. Diamond-drilling on the western half of the Newray has encountered a 4-ft. vein showing gold at a depth of 104-ft.——A small plant is being installed at the Nighthawk property and developments will be started.

The power-transmission line of the Northern Ontario Light & Power Co. to the Kirkland Lake district has been completed and is being tested. It has a capacity of 5000 hp., which is sufficient to supply the needs of the district for some time to come. Active operations will now be started on several properties that have been waiting for months for the promised power.

Further discoveries have been made at the 1600-ft. level of the Beaver Consolidated. Another high-grade vein running parallel to the first has been found at this depth. Its width is not known. Between the two there is 7 ft. of wall-rock heavily impregnated with native silver. The Temiskaming is sinking to the lower contact, which will shortly be reached, when it will connect with the Beaver workings, and continue sinking for an additional 200 ft. The Shamrock, adjoining the Beaver on the north, is in line with the strike and as soon as the work can be financed it will also sink to the 1600-ft. level. The Hargrave has struck a new vein of high-grade ore at the 75-ft. level in No. 1 shaft, from which it is shipping ore stated to carry over 2000 oz. per ton. The vein is 4 to 8 in. wide, with mineral extending into the wall-rock.——The production of the Nipissing during January was estimated at $282,698, being larger than the output for any month since July last. Profits for the month are estimated at $195,989.——The Kerr Lake produced 215,206 oz. in January.——The new vein recently discovered on the 800-ft. level of the Crown Reserve is showing well under development. The silver content will run high over 4 in. of the vein, the remaining 15 in. is comparatively low-grade. The annual report of the Trethewey shows that the mine, which had been closed but was re-opened and operated during the last seven months of the year, realized a profit of $64,664 and that with the returns from the sale of silver on hand from the previous year the company made a total profit of $79,865.——The Callow oil-flotation process is in successful operation at the Coniagas. The plant has a capacity of 150 tons daily.——At the Apex a highly mineralized 5-ft. vein has been cut at 900 ft. by diamond-drilling. The Gowganda Power Co., in which Philadelphia and Buffalo capitalists are largely interested, has initiated a hydro-electric power-development scheme in aid of the silver mining industry. The power-house will be at the South end of the Gowganda lake, and a dam will be built at Hanging Stone falls, on the east branch of the Montreal river. It is proposed to develop 1500 hp., in three units of 500 hp. each. The total cost will be about $300,000.

COBALT, ONTARIO

A NEW VEIN DISCOVERED IN THE BEAVER CONSOLIDATED AND HIGH-GRADE ORE IN THE CROWN RESERVE.

A second high-grade silver vein has been encountered at the 1600-ft. level of the Beaver Consolidated. These two veins are in the Keewatin formation that underlies the diabase in this part of the Cobalt silver area. Less than eight feet of rock separates the two veins and this also carries considerable native silver, assays running about 100 oz. per ton. The veins are from six to eight inches wide and carry upwards of 1000 oz. silver per ton.

The old Crown Reserve mine, which has paid over $6,000,000 in dividends in the past ten or twelve years and which was generally believed to be nearly worked out, has cut a 6-in. high-grade vein at the 800-ft. level, in territory that has been

considered unpromising. This development may add a number of years to the life of the Crown Reserve.

The Callow oil-flotation system recently installed at the Coniagas is returning a much higher recovery than was anticipated. The loss in silver is now reduced to less than one ounce per ton.

SPOKANE, WASHINGTON

The North-West Mining Convention.

The North-West Mining Convention was held at Spokane from February 19 to 25, under the auspices of the Spokane Mining Men's Club and the Spokane Chamber of Commerce. The program was arranged by the Spokane Engineering and Technical Association, aided by the local sections of the A. I. M. E., A. I. E. E., and the A. S. C. E. The acknowledged success of the convention was due in great part to the tireless efforts of G. B. Dennis, president of the North-West Mining Association, F. C. Bailey, its secretary, and L. K. Armstrong, chairman of the program committee, and to J. L. Paine, president of the Spokane Chamber of Commerce. More than 600 men were present. The U. S. Bureau of Mines was represented by D. A. Lyon, and the American Mining Congress by Henry Mace Payne of New York. Henry Landes, State geologist, represented Washington.

A large and representative collection of ores was on exhibition from many mining districts of the North-West. These included collections of copper ores from Michigan, and of silver and associated metals and minerals from Cobalt, Ontario; copper ores from Montana; representative ores from Nevada; gold ores from central Idaho, and silver, lead, zinc, and antimony from the Coeur d'Alene district of that State, and a varied collection from Bonner's Ferry district in the northern part of the Panhandle. There were good displays from Chewelah, Boundary, Keller, Methow, and other mining districts in Washington, and a large display from Rossland, Nelson, Ainsworth, Slocan, Boundary, and other parts of southern British Columbia. Among the ores that attracted most attention were tungsten and scheelite from Murray district, Idaho, and magnesite from the deposits lately discovered near Valley, Washington, by F. M. Handy, of the State College of Washington, at Pullman. A miniature electric-arc furnace designed by C. G. Warfel, assistant professor of metallurgy in the mining engineering department of the Washington State College, at Pullman, was shown in operation twice each day during the convention. It made a fair grade of steel from small charges of iron ore from Stevens county, Washington.

Frank A. Ross read a paper on 'The Pacific North-West Minerals in Peace and in War.' Henry Landes, State geologist of Washington, told of the work under his direction in that State, and urged the mining men to give his department their support in securing the necessary legislation and adequate appropriations. E. M. Murphy presented a paper on 'The Application of Electricity to Mining,' illustrating his subject by means of stereopticon views. F. W. Isham talked of his experiences in Alaska, also employing the stereopticon for the purpose of illustration. Montgomery Shugg, of Seattle, gave an illustrated talk on 'The Manufacture and Uses of Pure Iron,' and O. P. M. Goss, also of Seattle, took for his subject 'Some Developments in Timber Construction.' In connection with the latter talk it was shown how, under a new system, Douglas fir is used in such a way as to secure greater strength than under old methods, besides reducing the fire-risk. Modern methods of treating timbers with creosote to preserve them were illustrated—in particular, the heavy timbers used in mines, warehouses, store-buildings, and bridges.

With J. W. Turner as chairman, Thursday was Miners' and Prospectors' Day, and included entertaining talks by two or three old prospectors, chief among whom was Lew Wilmot, of Spokane, whose prospecting activities were commenced more than half a century ago, and who had some interesting stories to tell of placer-gold mining in various fields. Among other experiences he told of the arrival of the mail in the Clearwater country, Idaho, many years ago, when the miners had to pay $1 for each letter brought to them, and $1.25 per copy for the *Portland Oregonian*. He described the progress made in the use of placer-mining appliances from the primitive pan at first used, through the stages of the improved gold-pan, rocker, tom, sluice-box, and on to the time when 'giants' came into use in hydraulicking. Morris B. Parker, of Los Angeles, read a paper on the 'Mineral Resources of Methow, Washington,' which comprised a conservative and comprehensive survey of the resources of the Methow valley, together with notes on the geology and mineral resources of that region. Professor Arthur Lakes, of Nelson, B. C., read a paper on 'Fissure Veins.'

Among those who gave short talks at the luncheon on Thursday was Robert F. McElvenny, general superintendent for the Tacoma Smelting Co., who, speaking of the production and uses of copper, pointed out how much of this metal is used in ways that little is generally known. For instance, a surprisingly large quantity is used in frames around windows; millions of pounds in small bars go into storage batteries; much is used in german silver for such purposes as cans and shaving-stick tubes. Mr. McElvenny added that while smelter-men although students of the situation, know little of the outlook for copper, it was his personal view that the European war will be a long one, with copper in good demand while it lasts, but he thought there will be a sharp break at the conclusion of peace, then reconstruction and a recovery to better metal prices, to be followed by a comparatively high price for several years.

Russell Collins spoke of mining in the Coeur d'Alene region, and Professor Arthur Lakes expressed the opinion that there are still plenty of opportunities for discovery and development of new mining fields in British Columbia.

The Thursday afternoon session, under the auspices of the local section of the American Society of Civil Engineers, with Morton Macartney in the chair, was a symposium on cement and concrete. The papers presented were 'A Brief Outline of the Specifications for Cement and Cement-Concrete Aggregates,' by A. D. Butler, of Spokane; 'Cement Testing,' by J. P. Maider, of Spokane; 'Concrete in Pavements,' by C. R. Ege, of the Portland Cement Association, and 'Concrete in Highway Construction,' by H. J. Doolittle, assistant engineer of the Washington State Highway Department.

Columbia Section A. I. M. E.—On Friday morning many of the visitors attended the Spokane Stock Exchange during the regular call. At noon there was a large attendance at luncheon, Spokane business men being the hosts. Short talks were given by M. C. Butler, M.E., of the Colliery Engineering Co., Seattle, Washington; William W. Elmer, of Portland, Oregon; T. Z. Humphrey, of the Anaconda Copper Mining Co.; and Prof. E. K. Soper, of the University of Idaho. The afternoon session was under the auspices of the Columbia Section of the American Institute of Mining Engineers, with the chairman of the section, W. H. Linney, of Spokane, in the chair. The mining engineering department of the State College of Washington, at Pullman, Wash., was represented by Francis A. Thomson, head of the department; C. G. Warfel, assistant professor of metallurgy; Solon Shedd, professor of geology. The University of Idaho was represented by R. R. Goodrich, professor of metallurgy, and E. K. Soper, professor of mining engineering.

Professor F. A. Thomson, head of the Department of Mining Engineering, State College of Washington at Pullman, made an interesting address on flotation concentration, and Dr. R. E. Goodrich, Professor of Metallurgy at the University of Idaho, at Moscow, related his experience in the concentration of tungsten and gold from ores of the Murray mining district of Idaho. Progress at the Bunker Hill & Sullivan smelter formed the topic of an interesting paper by M. H. Sullivan, superintendent of the smelter.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

Two thousand five hundred pounds of placer gold, valued at $550,000, from the Iditarod district, arrived at Seward on January 9 for shipment to Seattle. It was transported on four dog-sleds from the Iditarod to Forty-Mile station on the Government railroad, where it was met and brought to Seward by special train. The trip of 500 miles from Iditarod to Forty-Mile station was made without mishap to any of the party.

JUNEAU. January returns from the mines on Douglas Island are officially stated as follows: Alaska Treadwell—29,554 tons crushed, producing $66,925.80 at a net profit of $30,846.64. The yield per ton was $2.26. Alaska United—52,934 tons crushed, producing $98,824.07. Average value of ore $1.97 at the Ready Bullion mine and of $1.86 at the 700-Foot mine. The Alaska Mexican crushed 10,395 tons, producing $16,090.68, at a loss of $1488.62.

ARIZONA

(Special Correspondence.)—The Big Jim Mining Co. at Oatman will build a 400-ton ore-mill, and the Gold Ore Mining Co., also at Oatman, will build a 50-ton mill. Ball-mills will be used instead of stamps for crushing, and pebble-mills for fine-grinding.

Oatman, February 24.

(Special Correspondence.)—The main shaft of the Nellie mine is down 385 ft. and has cut 32 ft. of quartz. Grab samples the last three rounds increased from $7.90 to $11 per ton. Sinking will be continued through the vein, which is 50 ft. wide, to 500 ft. The vein dips at 45°.——Charles Oster, of New York, is concluding the purchase of the Arizona-Rand and other groups covering a large acreage at Union Pass. This is a district of old producers, among the most prominent of which are the Sheep Trail, owned by the Sutro estate, and the Frisco. The Banner Gold in the same locality is down 250 ft. on the Sheep Trail vein in ore averaging $10 gold per ton.——Paul C. Thorne and J. A. Small, of Oatman, and R. A. Brundage, of Kingman, have incorporated the Mandalay Gold Mines company to develop six claims adjoining the Banner Gold. Mr. Small is cashier of the bank of Oatman.——Robert Franke, a mining engineer representing J. Parke Channing, has finished an examination of properties in the Black range, where Channing and associates are developing the Oatman Syndicate property. C. H. Palmer, Jr., of Los Angeles, has inspected the Adams and Sunnyside properties in the Black range. He made the first report on the United Eastern to Seeley W. Mudd, Philip Wiseman, and Frank Keith, when that property was presented for their consideration.

Oatman, February 24.

CALIFORNIA

(Special Correspondence.)—The stockholders of the Springfield Tunnel & Development Co., operating near Columbia, in Tuolumne county, will on March 10 vote upon a proposition to increase the capital stock of the corporation from $500,000 to $1,000,000.

W. L. Schmidt and W. H. Cone, of San Francisco, have assigned to Frank W. Hyland, of the same city, their option to purchase certain magnesite mines situated near Chinese Camp. Mr. Hyland is to pay royalties of 75c. and 25c. per ton of ore taken from the property, and is to deliver at the Quinn siding, on the Sierra railroad, magnesite ore for the Sedan Calcined Magnesite Company.——An Oakland company, of which Eugene Schmitz, of San Francisco, is president, has taken a bond on a magnesite mine owned by Henry Sims, situated a few miles from Chinese Camp. A hoist is to be installed at once.

The shaft at the Garfield mine, near Tuolumne, and on the south side of the North Fork, is to be sunk an additional 100 feet.

The water in the Columbia Basin, which was encountered several days ago, has been rising steadily despite continuous pumping at the rate of 600 gal. per minute. As a result work was discontinued on February 23, and the pump taken out.

Sonora, February 24.

(Special Correspondence.)—The Afterthought mine at Ingot is preparing to start up shortly. Twelve men are employed fixing the cars, tracks, and bridges. The mine has been unwatered to the 600-ft. level, where last spring was uncovered a large body of good-grade ore.——The Donkey mine, which recently was taken under a bond by the Mammoth Mining Co., is a mile and a half from Ingot. Nine men are erecting a head-frame. The new hoist was shipped from Kennett a week or so ago, and already is in place. Unwatering the shaft will be commenced within a week. Things look good for the district the coming spring.

Ingot, February 24.

(Special Correspondence.)—Thomas Lane is developing the old Lane & Tulloch mine three miles south of Angels. The mine is on the Mother Lode, a short distance north of Chaparral Hill. Considerable work was done on the property years ago by the former owners, and the prospect has been generally considered a most promising one. Sinking is in progress.

Angels, February 26.

(Special Correspondence.)—Construction of the electrolytic zinc plant of the Mammoth Co. is nearly finished, and it is reported the first run will be made early in March. At the smelter approximately 950 tons of ore is smelted daily, including 300 tons for the Balaklala mine, of the First National company. This summer heavy output will be made from the Stowell, Friday-Lowden and other properties acquired by the Mammoth company in the last three years. Fluxing ore for the smelter is largely drawn from the Reid mine, near Whitehouse. The ore is sent across the Sacramento river by an aerial tramway. Harvey Sallee is superintendent.

The Tom Greene group of three claims, at French Gulch, has been acquired by the Warren-Barnes company and preparations are being made for early operation. Some rich quartz was mined near surface in early days, and considerable milling-grade ore is in sight.

The Gardella Dredging Co. announces that two dredges of the latest type will be built this summer. They will distribute soil over the tailing, leaving the ground in fertile condition after dredging. No. 1 boat is dredging rich gravel on Clear creek, four miles below town.

Redding, February 27.

(Special Correspondence.)—During 1916 a total of 1600 cars of magnesite, worth approximately $800,000, was shipped from Tulare county. Of this amount more than 80% was from the Porterville district, while fully 90% was handled through companies operating at Porterville. At present from 10 to 15 cars of magnesite is being shipped daily from Porterville, about one-half of which is calcined. The aggregate value of the ore going out from Porterville daily is about $7000. With the opening of spring, when the roads are in better condition, it is

expected the daily output will reach $10,000. There are three companies operating magnesite-calcining plants in this district; the Tulare Mining Co., 12 miles east of Porterville, the Porterville Magnesite Co., whose plant is three miles north-east of the city, and the plant of the American Magnesite Co., situated in the city, the latter completed last fall, and which has been kept busy ever since in filling a contract with the American Refractories Co. The plant of the American Magnesite Co. is the largest of its kind in the United States. It cost $40,000 and embodies the latest ideas in equipment. The rotary kilns, 50 and 75 ft. long, the crushers, elevators, conveyors, and practically all parts of the plant, are operated by electric motors, which combined require 83 hp. A carload of oil is used every three days in the calcining-kilns, which are kept in operation day and night. About 35 men, working in three shifts of eight hours each, are employed at this plant, that alone is handling about 100 tons of raw ore per day.

Porterville, March 1.

The State Mining Bureau reports for the week ended February 24 that 25 new oil wells were started during the week; 18 wells to be inspected for the test of water shut-off; 17 wells are being drilled deeper, and nine are to be abandoned.

COLORADO

LEADVILLE. The strike at the Ontario tunnel in Iowa gulch becomes more important with development, according to reports received from the property. The ore-shoot is exposed for 40 ft. in the roof and floor of the tunnel and is strong in the breast with every indication of continuing to the site of the old Tiger shaft. It is believed that the ore-shoot in the tunnel is not the same as that opened from surface by the Tiger shaft, although it is in the same vein, which is said to be 100 ft. wide at surface. Cross-cutting is expected to expose another shoot.

Driving along the hanging wall is being pushed as rapidly as possible that a large section of the vein may be opened before shipping is commenced. The present condition of the roads to the property makes it impossible to haul ore, but it is believed that shipping can be started about the last of March, when, with some work, the roads can be improved. Mining men who have visited the property since the strike are unanimous in rating it as the biggest discovery made in the district in the last ten years and many state that it will develop into the largest mine that has been uncovered during the last twenty-five years.

Lessees on the Bartlett tunnel on Sugar Loaf are shipping a steady tonnage of silver ore from the vein recently opened through the winze near the breast of the tunnel. The development that has been accomplished on the ore-shoot shows it to be large and persistent. Operations will continue on a moderate scale until spring, when it is planned to install new machinery and make other necessary preparations for a heavy output.

The lessees that recently cut the old Fortune vein below the level of the Yak tunnel are experiencing trouble from a strong flow of water that was encountered in the ore-shoot and which tasks the capacity of the new electric pump. Development in the ore proceeds slowly, and a considerable tonnage has been extracted. It is believed that the water will gradually be drained by continuous pumping and will permit more extensive operations to be undertaken.

The sinking of the Jamie Lee shaft on Fryer hill is progressing favorably under contract, according to reports. Three shifts are employed in the shaft and are gaining depth at the rate of about four feet per day. What is believed to be the parting quartzite was cut recently and the shaft bottom is now in an underlying formation that is expected to be replaced by contact material at any time. A total depth of 60 ft. has been gained since sinking started a few weeks ago. Development in the upper workings of the Jamie Lee and other properties of the Leadville unit has exposed several new small bodies that are encouraging and indicate the presence of more extensive shoots in the territory.

A new leasing company of local mining men has taken charge of the Denver City property on Yankee hill and is preparing to resume operations. Under the supervision of Ike Jones, the machinery is being overhauled. Work underground will be started as soon as the equipment is ready.

Work has been resumed in the Bullion King mine at Silverton. The main adit is in over 1400 ft. At 950 ft. from the mouth a cross-cut has been driven west for 1800 ft. Finding nothing of value, a drift was started south from the cross-cut 750 ft. from its beginning at the adit and at 490 ft. from the cross-cut a mass of high-grade ore was found, and several carloads of ore was shipped at good profit. The new work is under the direction of Martin Tully.

During February ore shipments from Silverton were unusually heavy. The Sunnyside mine sent out 22 cars in 20 days, the Iowa-Tiger 19 cars, and Silver Lake 16 cars. The total shipments for the first 20 days of the month reached 136 carloads.

MICHIGAN

The Athens mine, at Negaunee, property of the Cleveland-Cliffs Iron Co. is to be provided with a pumping-plant, the biggest and most complete to be found anywhere for this kind of service. This pumping-engine will be a motor-driven, vertical lift of 2400 ft. It will be operated by an electric motor of 400 hp., current to be supplied from the company's electric system in which power stations are maintained at Dead River, Marquette, and Au Train. This pumping-plant will be built by the Prescott company, of Menominee, and will require six months to complete. It will also take a similar time in which to secure a motor. Work of cutting a station in the Athens shaft for the reception of the plant is under way.

MISSOURI

The digging of a well on a tract of land east of Center creek last November resulted in the opening of one of the most promising silicate properties in the district. The find was made in a district where zinc-ore mineralization was not anticipated. Silicate ore was encountered at a depth of 11 ft., and immediately the potential possibilities of the district became apparent. A company was organized and shaft sinking started. Developments from the first were so promising that by the time the shaft was nearing completion it was decided a small mill was warranted, and one has been erected and is in operation, turning out high-grade silicate at a rate of 40 tons per week.

The company is known as the M. M. & B. Mining Co., and principally interested are John and James Morgan of Duenweg, who have had experience in silicate mining. They believe the prospect for the development of a rich new field is good. The ore is found in a hard formation and is all mill-dirt, being somewhat similar to that of the silicate mines just south and south-east of Duenweg.

The lease consists of twenty acres. Operations are being conducted at a depth of 35 ft., but the shaft sinking showed that the ore persists to 75 feet.

MONTANA

The Bulwer and Elkhorn Queen are each shipping regularly to the smelters and the outlook for a large tonnage being sent out is good. At the old Elkhorn mine nothing is being done, but effort is being made to keep the dump from getting wet and freezing, which indicates that there is a project on foot for treating the dump. There are many thousands of tons of ore that carry silver and some lead, and with present methods the belief is that it can be made to pay. The property is owned by the Walkers of Salt Lake City. The report is that

the Walkers will resume mining at the Elkhorn before a great while and that the old property will again be opened and worked on an extensive scale.

For a mine that has been 'worked out' more than twice, the Elkhorn Queen is giving a good account of itself. There are ten men employed stoping ore from the drift at the 300-ft. level. They are working on what is considered part of an old shoot that was overlooked by former operators. The pay-streak is said to be 30 ft. wide and 60 ft. deep. The ore is sent to the East Helena smelter. When this shoot is exhausted the lessees intend to search the slate contact to find more pay ore. The old works were confined exclusively to the lime rock adjacent to the contact where the big pocket was found. The Bulwer mine is also shipping pay ore regularly.

After driving a tunnel through porphyry and slate on a mining claim at the head of Three Miles west of Helena, the Gilmores have found good ore in a drift from the bottom of a winze 200 ft. beneath the surface. The ore in the drift from the bottom of the winze is four inches wide and consists of carbonate of lead slightly colored with copper carbonate. Assays from this ore for silver and gold gave returns of 300 oz. silver and $12 in gold, with 40% lead.

L. L. Price, Jr., of the Original Bannack Mining Co., operating in the Bannack district reports a find of sulphide ore in the cross-cut from the Washington shaft on the 153-ft. level. Mr. Price said that they reached the orebody for which they had been cross-cutting for the last two months. The ore runs about 6% copper. In the Pioneer drift there has been opened a 30-ft. body of shipping ore and seven men are working on this drift. Ore-hauling by auto-trucks is being carried on day and night, each truck making six trips every 24 hours to the railroad station at Grant. The average haul of the two trucks has amounted to a car of ore per day. Two more trucks have arrived at Dillon and the output will now be four cars daily.

NEVADA

(Special Correspondence.)—The small town of Packard, situated four miles from Rochester, is attracting attention. It is the headquarters of the newly formed Rochester Combined Mines Co. A new town-site has been laid out adjacent to the old town of Packard, and the work of building has begun. A post-office will probably be established within a few weeks. By the purchase of the Eppelheimer group, where some silver-lead ore has been opened up, the holdings of the Combined Mines Co. have been increased to 84 claims. A 6-drill portable compressor has been installed and stoping begun on the Shepherd and Packard North Extension groups. This compressor is to be replaced by a larger one as soon as obtainable, and the portable outfit will be used to prospect other parts of the property. The motive power is furnished by a portable Diesel engine. Although power-lines run into the camp, supplying the Packard Co., it is the belief of the management that Diesel engines will furnish power at a cheaper rate, and this type will be used. The construction of the first unit of the proposed 600-ton cyanide-plant will be started as soon as supplies can be obtained. The present force of 20 men is to be increased to 100. J. W. Wilkey is superintendent.

Under the management of Jay A. Carpenter, plans are being made to work the Packard on a more extensive scale. The company has a large tonnage of ore blocked, and it is probable that the mill capacity will be increased to 150 or 200 tons daily. The present mill is handling 100 tons daily. The 120-D tunnel has advanced 900 ft. along the contact, and the 160-D, which is 80 ft. lower on the dip of the vein, is being pushed forward to reach the ore. The vein is a replacement-deposit in silicified and schistose rhyolite lying along a contact of flow-rhyolite and rhyolitic tuff. The latter was formerly mistaken for shale, which it greatly resembles. The value of the ore is almost entirely in silver, the gold content averaging less than 3c. per oz. of silver contained. Very little timber is required in mining the orebodies in this district. Total costs for mining, milling, and development for the past year have averaged under $5 per ton at the Packard, with better than 90% recovery.

As soon as the snow is off, work will be started on the Packard Extension group, adjoining the Packard on the south. These claims cover the southern end of a line of silicified rhyolite outcropping locally called dikes. These form a prominent feature of the topography of the district. They can be traced through the claims of the Rochester Mines Company, the Combined, and the Packard, and are intimately associated with the ore-deposits.——The new tramway of the Rochester Mines Company is about ready for use. Cold weather and delayed machinery prevented its completion. The new addition to the mill is in operation, increasing the capacity to over 200 tons daily.——Development work progresses steadily at the Merger, Nenzel-Crown Point, and United mines. The latter property has shipped several cars of medium-grade gold ore taken from shallow workings.

Prospecting is active around Lower Rochester, but no important discoveries have been made. The Winnemucca Mountain cyanide plant was shut-down recently, only a few months after beginning operations, due to a shortage of cyanide. The larger properties are protected by contracts.

Packard, February 25.

(Special Correspondence.)—Weather conditions have been bad, during the past 10 days, but the Nevada Consolidated Co. has been able to keep close to a normal production, shipping 50 tons per day of carbonate ores from its stock-pile to the smelter at Salt Lake City. This ore is high in silica. The Coppermines Co., by using a large amount of wood (from its own properties) together with some coal, has been able to keep the mill running on part time. The company has not yet accepted the mill. The General Engineering Co., of Salt Lake City, built it on contract and is now trying to get the saving up to standard. Several cars of concentrate have been shipped to the smelter at McGill; the Nevada Consolidated having made arrangements to smelt it.——The Boston-Ely, by its agent, H. S. Williams, is selling its surface equipment, after having spent over $150,000. A shaft was sunk 1200 ft. and a drift run to a vein 30 to 40 ft. wide. A winze was sunk 45 ft. to water-level, but as the flow of the water was heavy they went up on the 1100-ft. level and spent $50,000 driving and diamond-drilling to find a vein 600 to 800 ft. away that dipped from them. The only chance for a mine, in all probability, was below the water-level in the winze, in the sulphide zone. It was managed by a Boston stock-broker.——Superintendent Campbell, of the Ely Consolidated, has had to abandon, for the present, pumping from the Zack shaft. He will wait until the surface water from the melting snow runs off, and then install a large Cornish pump.——Lane Pearl, superintendent of the Ward mine lease, is ready to ship 50 tons per day to the Salt Lake smelters, as soon as the condition of the roads will permit. All the lessees are waiting for better roads, in order to ship ore. It is believed that there will be much activity in all lines of mining through the county this season; the town is full of people, it is hard to get a bed, and there is always a surplus of labor here, which is hard to account for, as they can secure work elsewhere.

Ely, February 24.

(Special Correspondence.)—The output of the leaching-plant of the Nevada Douglas Co. is increasing, and soon it will be handling 250 to 300 tons of ore daily, and later 500 tons per day, including a large quantity of custom ore. In January the company sent out 45 cars of selected ore, averaging around $2000 per carload. Arrangements are being completed for shipment of ore from the Ludwig mine to the Thompson smelter. That smelter is treating 750 tons of ore daily, most of it ore from the Mason Valley and Bluestone mines. It is said that the second unit will be blown-in soon. At present the company is refusing custom ore, but is expected to accept gold,

silver, and lead from nearby properties within 90 days. There are 150 men on the pay-roll.

The Copper Mountain group, under bond and option to the Jumbo Extension Co. of Goldfield, has been equipped with a hoist and compressor and machine-drills will be in operation within two weeks. The shaft has been sunk 30 ft. by hand-work and will be continued to a depth of several hundred feet if conditions remain encouraging. Several sets of lessees are mining and shipping good ore. The Pack Saddle Co. is preparing for shipments of gold ore from its mine in the Reservation district. The new ledge has been driven on for 30 ft. and is 5 ft. wide. Assays range from $30 to $50 per ton. Two rich streaks are accompanied by three feet of decomposed quartz.

Two feet of ore assaying $30 to $40 per ton has been discovered near the surface in the Reservation Hill mine. The value is largely in silver and lead. It is planned to put in a small pump, unwater the shaft, and resume sinking.

Yerington, February 26.

(Special Correspondence.)—Plans are nearly completed for the building of a railroad from Twin Falls, Idaho, to Jarbidge, and work will probably start as soon as the snow melts. The Oregon Short Line Co. has donated $5000 toward financing the enterprise, and an additional $3000 will be paid upon commencement of construction. Several local mining companies have agreed to contribute. The route has been surveyed through a mountainous country rendering road building difficult. There is 12 ft. of snow in the district.

The Elkora Mining Co. has reached the main orebody of the Long Hike mine in the lower workings, and a wide body of excellent ore is showing. It is estimated by the engineers that gold ore worth upward of $3,000,000 is exposed on the main levels, and plans for a mill will be made. Power will be generated by a plant located on the Jarbidge river. The Elkora company is composed largely of San Francisco people.

Jarbidge, February 28.

(Special Correspondence.)—The old Adelaide mine, 12 miles south of Golconda, is again a producer. Recently a four-inch air-lift was installed and the work of unwatering the main workings was begun. This lift is accomplishing its purpose at the rate of 300 gallons per minute. As the water receded from the upper workings, cross-cutting was begun. This has opened 18 ft. of ore that averages better than 7% copper. This property is under option to the John G. Kirchen interests and under the supervision of W. L. Taylor. Ore is going on the market as fast as teams can be had to transport it to the railroad.

Golconda, March 1.

Excavation is in progress for a 100-ton cyanide mill on the Great Western mine, the property of the Silver Mines Corporation at Hornsilver. It is expected that the mill will be ready by June. Hornsilver is 28 miles south of Goldfield. The ore has been successfully treated by cyanidation at Millers where 4000 tons was sent last year; it runs from $18 to $60 per ton. An 8-mile pipe-line for water is being laid.

The Goldfield Consolidated mine is being operated by 12 sets of lessees, and the company is re-modeling the flotation-plant, and expects to resume ore-treatment in a few days.

At the Cracker Jack mine a centrifugal-pump is to be utilized to handle the water, lifting it from the 320-ft. level. The inflow of water has increased lately, but the new pump, which has a capacity to lift 300,000 gallons daily, will take care of all the water that is likely to be developed for some time.

The Florence mine is being put in condition to grant leases, for which there have been numerous applications.

The *Tonopah Miner* reports for the week ended February 24 that the Tonopah Belmont sent to the mill 2906 tons, the Tonopah Mining 3000 tons, the Tonopah Extension 2380 tons, the Jim Butler 800 tons, the West End 648 tons, the Rescue 191 tons, the Halifax 210 tons, the Montana 100 tons, the Midway 57 tons, and the Cash Boy 20 tons, making the total production for the week 10,312 tons, the estimated value being $185,616. This valuation is calculated on the gross milling value of the ore.

UTAH

The Montana-Bingham tunnel is in 6000 ft. and has passed through several of the properties of Bingham. It has reached the Keystone Extension Mining Co.'s ground. The miners have cut 4½ ft. of vein matter and ore, showing galena, black oxide of copper, and copper glance. The strike is regarded as important, as it was at a point 1000 ft. on the pitch of the vein, is close to the end-line of the Keystone Extension ground, and when driving and raising are undertaken will afford opportunity for the blocking out of an immense orebody.

A streak of unpromising material found in sinking a winze from the 500-ft. level of the Three Kings property at Park City carries $1707 gold per ton, according to assays and samples taken last week. The streak is 8 in. wide and was found on the hanging-wall side of the winze at a depth of 160 ft. Several tons of the ore were saved last week, though considerable of the material was thrown over the dump before its value was suspected. On the foot-wall side of the winze is a streak of galena that carries 25.2% lead with 11.8 oz. silver and 60c. gold per ton. The winze is being sunk in a fissure that is 17 ft. wide in the limestone. The objective of the work is the underlying limestone-quartzite contact, where the main deposits of ore are expected to be found. The Three Kings property comprises 157 acres near Park City on the north, and close to the Silver King Coalition and Consolidated properties.

For two weeks the Miller Hill Mining Co., operating in American Fork canyon, has been striving to overcome the flow of gas in the main tunnel, now in about 1300 ft. Much equipment has been installed and, by perseverance and courage, the men working at intervals that usually lasted only a few minutes, the shots were placed and fired. But the flow of gas has increased, rather than diminished, and for three days the miners have been unable to reach the face of the tunnel, in spite of their efforts. Additional ventilation fans will be provided by means of which it is hoped the work can be continued, as it is thought a body of ore is near.

A strike of rich ore was made at the King of the Hills mine in Beaver county last week when a body of red oxide of copper was broken into in the winze at a depth of 250 ft. It is reported that the whole face is in good ore with a streak of high-grade 18 in. wide.

The high lead market has increased the earnings of the Bingham Mines Co. and its subsidiary, Eagle & Blue Bell, which is controlled by Bingham through the stock ownership. As both companies receive the prevailing price for lead the week it is smelted, they are in a position to take advantage of the high prices. In the Eagle & Blue Bell, more good ground is being opened and the prospects of a larger production are favorable.

The Victoria, which was bought by Bingham last year, is developing satisfactorily. When shipments were started from this new property the smelters refused the ore, due to their crowded condition. Shipments of ore lately have been resumed. In December profits from this property totaled $9800.

According to W. K. Yorston, general manager of the building of the narrow-gauge railroad up Little Cottonwood canyon from Wasatch to the mines at Alta, the road has taken out its first ore from Tanner's Flat and hauled it to the Salt Lake & Alta railroad at Wasatch.

By the time that the snow is off the road will be finished up to the South Hecla and to the Emma Consolidated properties. Track is going in at the rate of 500 ft. per day and this will be kept up until better progress can be made.

With the present equipment the road can handle 500 tons of ore per day. The road is a 36-in. narrow-gauge track, equipped with a Shay engine and dump cars.

WASHINGTON

(Special Correspondence.)—The Electric Point Mining Co. has added to its equipment two 30-hp. Pneumatic Tool Co. compressors. The mine is producing daily over 100 tons of lead carbonate and three tons of galena. The Gladstone Mining Co. has found carbonate ore on the 200-ft. level.

Cummins, February 20.

CHEWELAH. During 1916 the United Copper Mining Co. produced 1,179,178 lb. of copper and 159,271 oz. of silver, giving a profit of $121,581. Monthly dividends of 1%, or $10,000, are being paid. On the 1000-ft. level the ore-shoot is from 18 to 36 in. wide for 250 ft. length, rich in copper and silver. The mill was re-modeled to good advantage. Concentrate contains 15% copper and 60 oz. silver per ton.

CANADA

The old Vipond mill at Porcupine, now operated by the Porcupine V. N. T. company (a consolidation of the Vipond and North Thompson) has been milling approximately 100 tons daily, from which the bullion yield has been $8.50 per ton. The assay of Vipond ore has been assumed to average $8 to $9 gross per ton, so that the actual recovery of $8.50 per ton indicates a better return than assumed from average ore.

The gold excitement at Elk Lake shows no signs of diminishing. About 300 claims have been staked.

There is the usual proportion of snow-staking, but there are many properties that show gold and when spring opens there will be many more. The ground has been known for years by the Elk Lake prospectors as one of the best looking formations in the mining country and development work on a small scale has been done at several different points, but it seemed to be impossible to interest capital, and big low-grade gold mines cannot be developed without money and lots of it.

During the month of January the Nipissing mined ore of an estimated value of $173,988, and made shipments from Nipissing and custom ores of an estimated net value of $301,692, according to the monthly report of R. B. Watson. The production was below normal during January, on account of the usual shut-down at both mills for the purpose of making the annual clean-up changes and repairs in the equipment.

In the 73-shaft workings, development of vein 400 was continued by sinking two winzes below the fifth level. The south winze reached a depth of 41 ft. and was then stopped, as the Keewatin formation had been reached. The ore continued down to the Keewatin, but was low grade below a depth of 21 ft. The north winze had reached a depth of 10 ft. on the first of February. The ore was of good width, averaging 6 in. wide and from 1000 to 2000 oz. per ton. Several crosscuts have been run from the fifth level in the hope of picking up parallel veins, but nothing so far has been developed outside of the main vein.

MEXICO

In connection with preparations by the American Smelting & Refining Co. for re-opening its smelter at Monterrey, it is stated that arrangements for operation of this plant have been made between the company and the Carranza government. A special train is to be run from Laredo, Texas, in a few days to Monterrey, carrying a number of Americans to be employed in the plant. The smelter is said to have large quantities of coke, and the company plans to operate its own trains for taking in supplies and bringing out products, as well as transporting ore to plant from the mines. The ore will be obtained mainly from Cerralvo, Matehuala, and Monclova. Advices have been received that the San Toy, Chihuahua, and Santo Domingo mining companies have resumed operations in Santa Eulalia district near Chihuahua. These three companies are employing 1500 men.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

WALTER HARVEY WEED is at Phoenix.

OTTO SUSSMAN is about to go to Chile.

HOWARD D. SMITH has returned from Missouri.

JAMES MURRAY, of Butte, has been taking a holiday in California.

A. B. W. HODGES came to San Francisco from Los Angeles for a few days.

THOMAS B. STEARNS was in San Francisco for a couple of days last week.

CARLOS W. VAN LAW, now residing at Boston, was in San Francisco last week.

WILL C. HIGGINS, editor of the Salt Lake *Mining Review* has been visiting California.

FRANK OLDFIELD has arrived in San Francisco from Jalisco, Mexico, on a well-earned holiday.

WALTER STRACHE sails from New York for Brazil, March 7, on a three months' professional trip.

J. B. TYRRELL, of Toronto, and J. W. Bell, of Montreal, attended the A. I. M. E. meeting at New York.

MAXWELL C. MILTON, of Tucson, was married on March 6 to Miss Josephine Johnson, at Oakland, California.

F. H. MINARD has been appointed consulting engineer to the Mineral Hill Consolidated Copper Co., at Tucson, Arizona.

E. J. SCHRADER has recovered from the effects of an operation and has resumed charge of the Pittsburg Dolores Mine, at Rockland, Nevada.

RICHARD B. STANFORD has resigned as manager of the Bonanza mine, in Nicaragua, and is at home again at New Orleans.

GEORGE H. HARBORDT has resigned as superintendent of the refinery at smelter No. 2, Monterrey, Mexico, to accept a position as superintendent of the Cerralvo smelter belonging to the Cia. de Minerales y Metales, S. A., in Nuevo Leon.

Obituary

HERMANN A. KELLER was killed by a mine-locomotive at Clifton, Arizona, on February 16. He was a mining engineer widely known and respected.

JOHN ADAMS CHURCH, one of the first graduates of the Columbia School of Mines and a distinguished mining engineer, died in New York on February 12, at the age of 74. He was identified with the early systematic development of the Tombstone mines and took a prominent part in the public discussion of Comstock geology. About 35 years ago he was engaged as advisor to the Chinese government. After that he became established as a consulting engineer in New York. He was a man of the highest character, clear-headed, independent and original in his ideas.

EDWARD DYER PETERS, the author of 'The Principles of Copper Smelting' and professor of non-ferrous metallurgy in Harvard University, died at his home at Boston on February 17, at the age of 67. A native of Dorchester, Mass., he graduated from Freiberg in 1869 and then studied at Harvard, where he received the degree of doctor of medicine in 1877. After a wide experience as a metallurgist in the West, he was engaged to report on the Mount Lyell mine in Tasmania and then acted in an advisory capacity. This and the publication of his first book, 'Modern Copper Smelting,' in 1887, made his reputation. In 1903 he became lecturer on metallurgy at Harvard and in 1904 professor. He proved a splendid teacher and expositor. To his books the technology of copper metallurgy owes a great debt. His death is a great loss to Harvard.

THE METAL MARKET

METAL PRICES

San Francisco, March 6.

Antimony, cents per pound	24
Electrolytic copper, cents per pound	36
Pig lead, cents per pound	9.50—10.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$110—115
Spelter, cents per pound	12
Tin, cents per pound	47.50
Zinc-dust, cents per pound	18—20

ORE PRICES

San Francisco, March 6.

Antimony, 50% metal, per unit	$2.00
Chrome, 40% and over, f.o.b. cars California, per ton	18.00—20.00
Magnesite, crude, per ton	8.00—10.00
Tungsten, 60% WO_3 per unit	18.00—18.50
Manganese, 50% (under 35% metal not desired)	29.00

Manganese ore, 40 to 45%, sells f.o.b. Chicago at 58c. per unit with a penalty of 50c. per unit for more than 8% silica.

New York, February 28.

Tungsten: A shortage of spot tungsten, especially scheelite, caused the market to strengthen in the past few days, and $18 per unit has been paid for prompt material. Spot wolframite has been taken at $16.50 to $17 per unit. A broker reports that an export enquiry calls for 100 tons is under negotiation, while another foreign enquiry calls for 50 tons.

Molybdenite: No offerings are reported, and the only price that can be given is that at which the last sale was made—$1.80 per lb. for 90% concentrate. Some new properties in the West are to be worked, according to report, but it will be months before the product is on the market.

EASTERN METAL MARKET

(By wire from New York.)

March 6.—Copper is quiet. Lead, spot 10 to 11c., with market nominal. Spelter is firm and quiet.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Feb. 28	36.50	Jan. 23	29.34
Mch. 1	36.25	" 30	31.91
" 2	36.25	Feb. 6	33.00
" 3	36.25	" 13	33.90
" 4	Sunday	" 20	35.37
" 5	36.25	" 27	36.00
" 6	36.25	Mch. 6	36.29

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	....	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

The Allouez Mining Co. has declared a dividend of $3 per share, payable April 4. This makes $6 per share paid thus far in 1917.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Feb. 28	77.00	Jan. 23	75.37
Mch. 1	76.50	" 30	75.87
" 2	76.25	Feb. 6	76.79
" 3	76.25	" 13	77.62
" 4	Sunday	" 20	78.41
" 5	76.62	" 27	77.37
" 6	76.37	Mch. 6	76.50

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	48.85	56.76	75.41	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	....	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Feb. 28	11.75	Jan. 23	7.72
Mch. 1	11.50	" 30	8.02
" 2	11.50	Feb. 6	8.41
" 3	11.50	" 13	8.60
" 4	Sunday	" 20	9.58
" 5	11.50	" 27	9.45
" 6	11.50	Mch. 6	11.54

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	....	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

On March 3 the Bunker Hill & Sullivan Mining & Concentrating Co. paid dividend No. 246 of $81,750. On the same day, an extra dividend, No. 247, of $81,750. This brings the total dividends paid by this company to $18,980,250.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Feb. 28	10.75	Jan. 23	10.00
Mch. 1	10.87	" 30	10.41
" 2	10.87	Feb. 6	10.06
" 3	10.87	" 13	10.52
" 4	Sunday	" 20	10.54
" 5	10.87	" 27	10.70
" 6	10.87	Mch. 6	10.85

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	....	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Feb. 6	90.00	Feb. 20	140.00
" 13	140.00	" 27	135.00
		" 6	115.00

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	....	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	....	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

ALUMINUM

Quotations remain unchanged at 57 to 59c. for No. 1 virgin aluminum, 98 to 99% pure. The market is quiet.

ANTIMONY

Ore from South America is being offered for the first time since the break in prices last year. March shipment is quoted at $2.30 per unit.

PLATINUM

Price of platinum, New York, is $105 per ounce for soft metal and $111 for hard.

Eastern Metal Market

New York, February 27.

The freight situation has cleared up a little, and a continuance in this direction is expected to reduce the excessive premiums which are asked for spot metals, particularly lead and antimony.

Copper is as strong as ever. The Government is asking makers of brass and copper products as to the amount of stock they carry, their capacities, and what they can be depended on to furnish in an emergency.

That zinc is not at a higher price is a puzzle to the trade. It continues quiet.

Some lead is getting through from the middle West, but hardly enough to relieve the shortage. Some consumers are selling from their stock, finding it the easiest way to make a profit.

Tin is higher because of apprehension that deliveries from abroad may be interrupted.

Antimony is a little easier.

COPPER

The market continues very strong, with just enough business to establish a price level, and little more. With nearby metal ranging from 36 to 37c. consumers are not disposed to buy except for absolute needs. In most cases they buy to cover contracts when the latter are booked, although sometimes they do not do this, preferring to take chances on the future. Incidentally, fewer contracts are being booked for munitions material. Spot electrolytic copper is scarcer than ever, and one or two consumers who could not find a source of supply have purchased Lake instead, paying 36.50 to 36.75c. for March and April delivery. March electrolytic ranges from 36 to 36.50c. April has been offered at 35.50c., May at 35c., June at 34.50c., third quarter at 32c., and August and September at 31.50c.

LEAD

The railroad situation is clearing up, and more lead is getting through to the seaboard, but not enough greatly to relieve the situation. March shipment from the West is quoted at 9.25c., New York, and April at 9c., whereas spot is quoted at 10.25 to 10.75c. Consumers are not eager to buy at the latter prices, for they realize that they are based on abnormal transportation difficulties. Some members of the trade predict a big slump when the lead in transit begins to arrive in considerable quantities, and they say the drop will be made doubly worse because easier freight conditions will mean that ore will be rendered more plentiful also. Under the circumstances the bulk of buyers have been unwilling to buy for April, or beyond.

TIN

While not a single ship bearing tin has so far been lost as a result of Germany's present submarine warfare (one was lost several months ago) the trade, and consumers are beginning to become alarmed over the aggregate tonnage of ships sent to the bottom. They realize that the situation is becoming more acute. For this reason the market has stiffened in the past week, and Straits tin has again exceeded 50c., the quotation yesterday being 50.50c., against 48.75c., a week previous. The situation is causing more consumers who heretofore have used Straits tin only, to turn to Banca, Chinese, Bolivian, and Australian tin. On one or two days of the week a fair business was done, but nothing exceptional. It is expected that the February statistics will make another good showing. The arrivals up to February 27, totaled 3655 tons, and there was afloat on that day 3323 tons.

ZINC

Consumers have shown but little interest in the past week, and the market has been almost at a standstill. The quotation for nearby delivery (not spot) is about 10.50c., New York, and 10.25c., St. Louis. Second quarter is about 9.75c., St. Louis. These prices are a source of great disappointment to the producers, who, like everyone else, are puzzled to know why zinc prices have not maintained a better relation to those for copper. With ore around $90 a ton, the producers assert that zinc costs 10c. or more per pound, and they see very little profit. They ask: if prices are not high in winter, when will they be high? At present levels they are not inclined to sell future positions, and are taking prompt business sparingly. In the latter part of last week there was fair inquiry, but it has since died out with little accomplished. The London quotation for spot yesterday was £47, unchanged from that of a week previous. The exports, February 1 to 27, totaled 8895 tons. Sheet zinc is unchanged at 21c., f.o.b. mill, carload lots, 8% off for cash.

Current Prices for Chemicals on the Pacific Coast

As prices for chemicals are now fairly stable, we are able to give the following list prepared by Braun-Knecht-Heimann Co., Saan Francisco.

Prices quoted are for ordinary quantities in packages as specified. For round lots lower prices may be expected, while in smaller quantities advanced prices are ordinarily charged. Prices named are f.o.b. San Francisco and subject to fluctuation. Other conditions govern Mexico and foreign business.

	Min.	Max.
Acid, sulphuric, com'l, 66°, drums, per 100 lb..	$ 2.00	$ 2.25
Acid sulphuric, com'l, 60°, carboy, per 100 lb..	3.00	3.75
Acid, sulphuric, C. P., 9-lb. bottle, bbl., per lb.	0.18	0.22
Acid, sulphuric, C. P., bulk, carboy, per lb....	0.12	0.13¼
Acid, muriatic, com'l, carboy, per lb.....	0.02½	0.03½
Acid, muriatic, C. P., 6-lb. bottle, bbl., per lb...	0.21½	0.25½
Acid, muriatic, C. P., bulk, carboy, per lb.....	0.15	0.16½
Acid, nitric, com'l, carboy, per 100 lb.....	0.07½	0.08
Acid, nitric, C. P., 7-lb. bottle, bbl., per lb....	0.25	0.29
Acid, nitric, C. P., bulk, carboy, per lb*.....	0.18	0.19¾
Argol, ground, bbl., per lb.....	0.10	0.30
Bismuth, per lb.....	2.85	3.00
Borax, cryst. and conc., bags, per 100 lb.....	7.00	7.90
Borax, powdered, bbl., per 100 lb.....	7.50	8.35
Borax glass, gd. 30 mesh, cases, tin lined, per 100 lb.	17.00	19.50
Bone ash, 60 to 80 mesh, bbl., per 100 lb.....	5.50	6.50
Bromine, 1-lb. bottle, per lb.....	1.40	1.55
Clay, domestic fire, sack, per 100 lb.....	0.75	1.50
Cresylic acid, 95-97%, drums 110 gal., per gal.	1.00	1.25
Cyanide, 96-98%, 200-lb. cases, per lb.....	0.40	0.50
Flotation oils, bbl. 50 gal., per gal.....	0.50	2.50
Iodine, 1-lb. lote, per lb.....	3.75	4.25
Lead acetate, brown broken, casks, per 100 lb.	13.50	16.50
Lead acetate, white broken, casks, per 100 lb.	15.00	18.00
Lead acetate, white, crystals, per 100 lb.....	17.00	20.00
Lead, C. P., test., gran., per 100 lb.....	15.00	18.00
Lead, C. P., sheet, per 100 lb.....	15.00	18.00
Litharge, C. P., silver free, per 100 lb.....	14.00	16.00
Litharge, com'l, per 100 lb.....	9.50	11.50
Magnesite, bbls., per ton.....	40.00	50.00
Manganese ox., blk., dom. in bags, per ton....	20.00	25.00
Manganese ox., blk., Caucasian, in casks, per ton (85% MnO_2—¾% Fe).....	150.00	200.00
Nitre, double ref'd, small cryst., bbl., per lb....	0.38	0.40
Nitre, double ref'd, granular, bbl., per lb.....	0.34	0.35
Nitre, double, ref'd, powdered, bby., per lb....	0.34	0.36
Potassium bicarbonate, cryst., per lb.....	1.35	1.40
Potassium carbonate, calcined, per lb.....	0.60	0.70
Potassium permanganate, drum, per lb.....	3.75	4.00
Silica, powdered, bags, per lb.....	0.01¼	0.05
Silver nitrate, per lb., 1-lb. box.....	8.50	9.00
Soda, carbonate (ash), bbl., per 100 lb.....	4.00	4.25
Soda, bicarbonate, bbl., per 100 lb.....	2.50	3.00
Soda, caustic, ground, 98%, bbl., per 100 lb....	5.25	5.75
Soda, caustic, solid, 76%, drums, per 100 lb....	5.00	5.50
Sodium sulphide, drums, per lb.....	0.03½	0.04½
Strontium nitrate, kegs, per lb.....	0.28	0.30
Sulphur, sack 110 lb., per 100 lb.....	2.30	3.60
Zinc shaving, 850 fine, bbl., per 100 lb.....	28.00	30.00
Zinc sheet, No. 9—18 by 84, drum, per 100 lb..	26.00	28.00

*Extra charge for packing nitric acid for shipment to conform to regulations.

Book Reviews

THE PRINCIPLES OF RHETORIC. By Adams Sherman Hill. Pp. 430. 12mo. American Book Company. For sale by the MINING AND SCIENTIFIC PRESS. Price, $1.50.

This book on the art of writing, by the Professor of Rhetoric in Harvard, ought to be better known to mining engineers, for it is a most useful guide to correct expression. "Rhetoric is the art of efficient communication by language," says Mr. Hill. Therefore, he adds, "rhetoric implies the presence, in fact or in imagination, of at least two persons—the speaker or the writer, and the person spoken to or written to." Thus we come to the principal rule in writing: Remember the reader. The first chapter is devoted to 'Good Use.' At once we find that the author has a happy way of illustrating his teaching with plentiful examples, giving point to his remarks. These arouse intelligent interest and afford practical hints to the student. In choosing forms of expression, "the simpler expression is also the shorter," and it is to be preferred. Then come 'Violations of Good Use,' including barbarisms, improprieties, and solecisms. Here the average writer will find much to learn, recognizing many of his own aberrations. Mr. Hill realizes that "though truth is one, the ways of communicating truth are many." So he is not dictatorial. He tells the student that careful writers avoid this or that usage. By attacking undesirable ways of speech in a persuasive manner he is likely to be more convincing than by the mere assertion of authority, for the proper use of words is largely a matter of taste; yet the art of expression is based on scientific principles; there is a mechanics of writing that can be studied to advantage, particularly in technology. Under 'Solecisms,' the student finds good advice concerning 'shall' and 'will,' doubtful plurals, and the split infinitive. The next chapter is 'Choice of Words.' Under this heading he discusses 'clearness,' 'force,' and 'ease.' Again the wealth of illustrative quotations from good authors adds greatly to the interest of the teaching. It is human to err in writing as in other matters, and much may be learned by noting the effect of blunders made by others. It is a cheap kind of experience and may save a man from a more costly kind. Choose words adapted to convey your meaning to persons for whom your writing is intended; use only as many words as are needed to convey your meaning; arrange those words in the order most likely to convey that meaning. To gather words, the student should study the dictionary, preferring a small one that can be picked up easily; also read the great writers; copy fine passages; and practice composition in order to gain a command over words. Swimming cannot be learned on dry land. Practice the literary scales in order to obtain dexterity. Mr. Hill quotes from Quintilian: "It is not enough to use language that *may* be understood, you should use language that *must* be understood." This means the taking of pains. Most of the bad technical writing is due less to ignorance than to simple lack of care. "Many of the principles of selection which [that] apply to clearness apply to force also." This reminds us that Mr. Hill allows euphony to decide between the use of *who* or *which* and the use of *that*. The reviewer has found it helpful in technical writing to sacrifice such euphony to the clearness that can be gained by giving these relative pronouns their special duties. The relative clause introduced by *who* or *which* is supplementary and continuative, whereas the clause introduced by *that* is restrictive and definitive. In the next chapter, entitled 'Number of words,' the student is taught how clearness, force, and ease are rendered possible.

"A sentence should contain every word that helps to communicate thought or feeling with clearness, force, and ease, but not one word more." Some writers treat their sentences like a stage-coach in which there is said to be room always for one more passenger. The effective use of connectives—like 'though,' 'for,' 'hence,' 'indeed'—serves to link ideas into a consistent whole. As Coleridge said, such connectives are "the hooks and eyes of the memory." "To multiply words without cause is to be tedious." The smoke hides the fire. "Clearness requires that the words and the groups of words which are near to one another in thought shall be near in expression, and that those which are separate in thought shall be separate in expression." This is a rule that will help the writer out of much obscurity. Of the four kinds of composition recognized by Mr. Hill, two may be supposed to include technical writing: description and exposition. These two are alike in aiming to convey information. "The paramount quality in all such writing should be clearness." "The difference between judicious and injudicious repetition is not so much in the amount of repetition as in the selection of the place for it." "Good arrangement is at least one-half of sound exposition. Order is often equivalent to explanation." "In every case, an exposition should be adapted to the probable hearer or reader." So we come again to the first rule of effective writing, technical or otherwise: Remember the reader. We must leave the subject here. We commend Mr. Hill's book to the young mining engineer as one that may guide him safely in the attempt to write seriously and as one to stimulate him to the attainment of a pleasant style. The book is full of lucid definitions, high scholarship and good sense being united to skilful presentation. As already mentioned, the reader is given a large number of interesting examples—indeed the longer quotations constitute remarkable examples of the best literary styles. The reviewer has found the book useful, therefore he commends it to his fellow-students.—T. A. R.

Recent Publications

U. S. Geological Survey, Washington, D. C., 1917:

GARRISON AND PHILIPSBURG PHOSPHATE FIELDS, MONTANA. By J. T. Pardee. Bulletin 640-K. P. 34. Maps.

ANTICLINES IN THE BLACK FEET INDIAN RESERVATION, MONTANA. By Eugene Stebinger. Bulletin 641-J. P. 25. Maps.

COALS IN THE AREA BETWEEN BON AIR AND CLIFTY, TENNESSEE. By Charles Butts. Bulletin 641-K. P. 4. Map.

RELATIONS OF THE EMBAR AND CHUGWATER FORMATIONS IN CENTRAL WYOMING. By D. Dale Condit. Professional paper 98-O. P. 8. Ill., charts.

CONTRIBUTIONS TO THE GEOLOGY AND PALEONTOLOGY OF SAN JUAN COUNTY, NEW MEXICO. By C. M. Bauer. Professional paper 98-P. P. 8. Ill., charts.

STUDIES OF THE ORIGIN OF MISSOURI CHERTS AND ZINC ORES. By G. H. Cox, R. S. Dean, and V. H. Gottschalk. P. 34. Illustrated. Bulletin of School of Mines and Metallurgy, University of Missouri, Rolla, 1916.

Kerosene-Engines

The Witte Engine Works has recently made large extensions to its plant to take care of the increasing demand for kerosene-engines. This type of engine has gained in favor through the comparatively low fuel-costs and power efficiency. The engine has been improved and perfected by the Witte company and several new types developed to meet various power requirements. These engines are lower in price than gasoline-engines, which also are made by the Witte company, and are sold on a 5-year guarantee covering fuel consumption. Some interesting figures have been compiled by the company showing the relative efficiency of this type of engine and fuel and engines of other types that will be sent upon request by addressing Witte Engine Works, 3890 Oakland avenue, Kansas City, Missouri.

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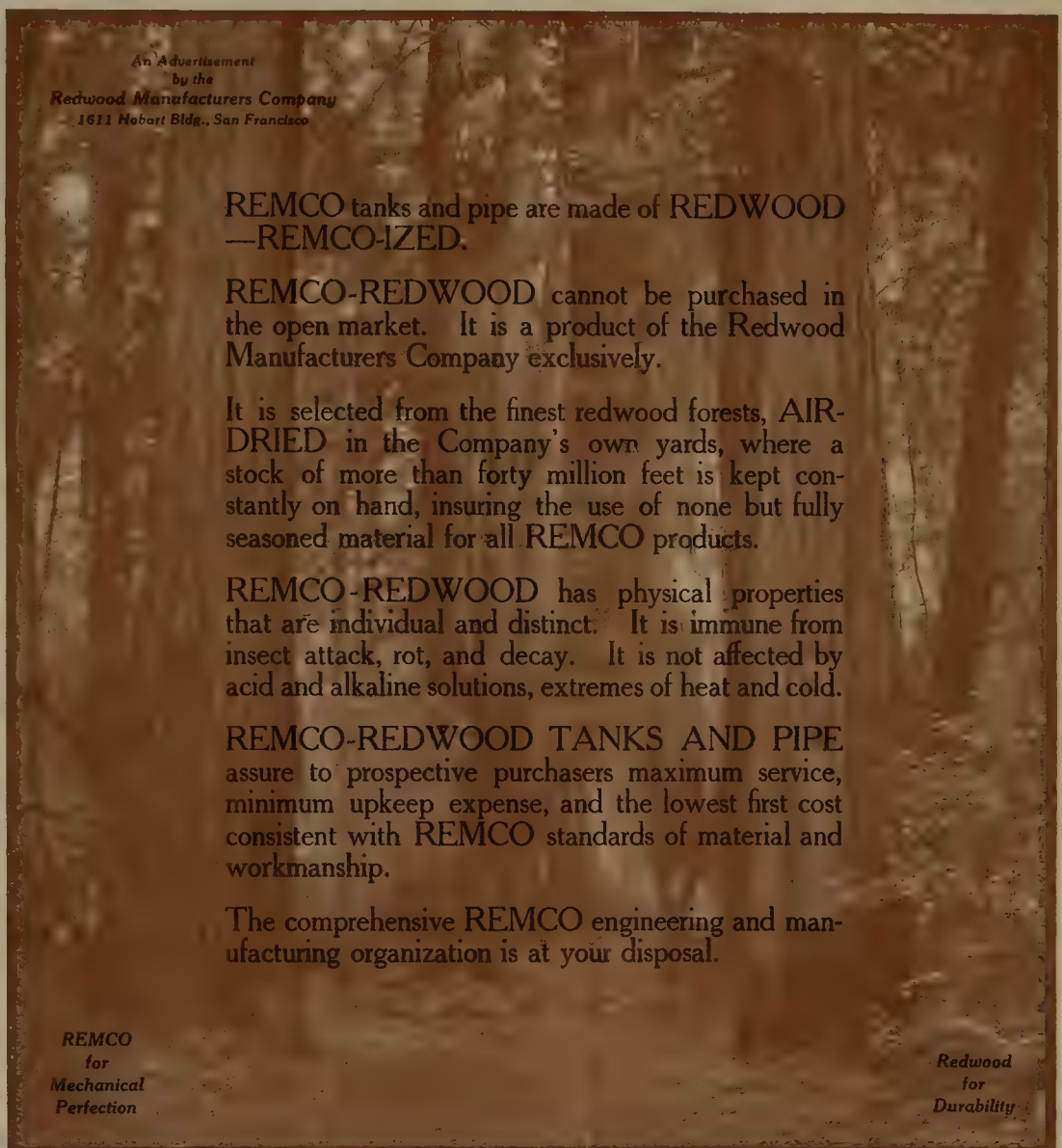
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by the
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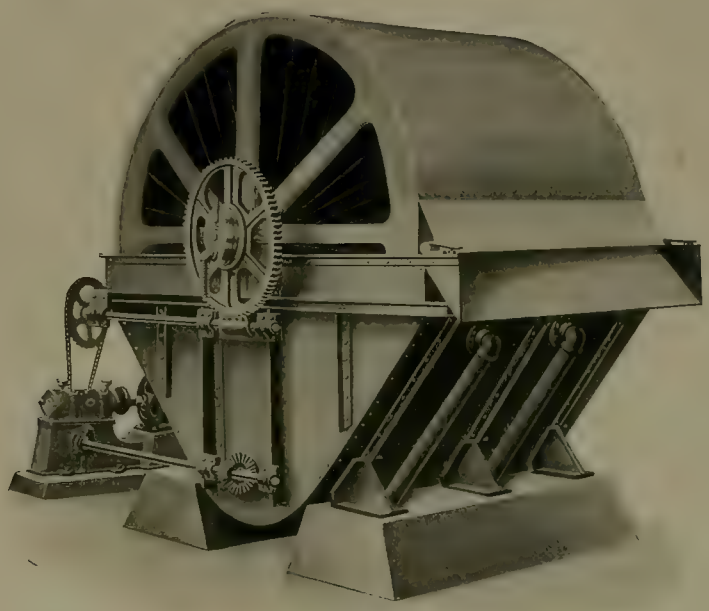
In This Issue:

The History of Flotation
Interview with T. H. Leggett



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BUSINESS STAFF:
C. T. HUTCHINSON, Manager
E. H. LESLIE
600 Fisher Bldg., Chicago
A. S. BREAKEY
1760 Woolworth Bldg., New York

Science has no enemy save the ignorant

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EDITORIAL

T. A. RICKARD, Editor

OCEAN transport is now so restricted and expensive that the Selby smelter is sending its lead from San Francisco to New York by railroad.

LEACHING of low-grade oxidized copper ores is opening the way for utilizing the waste sulphur-fume from Western smelters. A recent instance is afforded by the Calumet & Arizona, which company will this month bring into operation a sulphuric-acid plant at Douglas, Arizona, making acid for leaching the ore at Ajo.

CYANIDE is selling locally for 95 cents per pound and there is a tendency for the price to drop. Most of the cyanide sold here recently has come from Japan. One Mexican mine obtained 50 tons, for example, from this source. It appears that the British authorities allowed a supply of cyanide to go to Japan in the early days of the War and the Japanese are re-selling it now at a big profit.

CARRANZA has elected himself President. The reports are that he voted for himself almost unanimously. It is pleasing to record this modicum of self-restraint. Meanwhile Zapata remains the unconquered champion of the peasantry in the South, Villa menaces the security of the Carranza dictatorship in the North, and the constitution in defence of which Carranza unfurled his banner has been torn to shreds. Alas, poor Mexico!

RICHARD P. ROTHWELL, if he were alive today, would be astonished to find the technical journal that he established now one of an agglomeration of 10 papers under a single control. The passing of the *Engineering and Mining Journal*, with the other four publications controlled until his death a year ago by John A. Hill, to the group of trade journals owned by the McGraw Publishing Company is an event of some interest. Mr. James H. McGraw threatens to become the Hearst or Northcliffe of trade-paperdom, but, we are glad to add, he has a sense of decency foreign to Mr. Hearst and a scrupulousness disdained by Lord Northcliffe. If the technical-trade press is to be dominated by one man, it is fortunate that he is a man of such high character as Mr. McGraw.

WILL IRWIN in the *Saturday Evening Post*, referring to the American engineer who blew the top off the Col de Lana, on the Italian battle-front, says that he is a graduate of Cornell and has his office in San Francisco. Just half of this is correct. He is an Italian and he is a graduate of the Columbia School of Mines, and his name is Gelasio Caetani—and he is now in Macedonia, where he carries with him the best wishes of many American engineers. By the way, his cousin, Lionel Lindsay, a graduate of the Mining School in the University of California, and sometime assistant-editor in this office, has been promoted to major and awarded the Military Cross for conspicuous bravery while serving with the British army in France.

VARIOUS announcements have been made by the Mexican government concerning the working of mines; they are changed so often and they come so fast that they are difficult to follow. Therefore an outline of the position as it now exists will be welcome to many of our readers. On September 14, 1916, it was decreed that all mines must be in operation within two months. On November 14, this decree was prorogued, that is, the interval mentioned was extended to February 14, 1917. On February 16, 1917, it was announced that (1) such mining companies as had explained to the Secretaria de Fomento why they could not comply with the decree would be given a last extension of time, to be fixed by the Secretaria, taking into consideration the special conditions existing on each mining property; (2) such companies as have not asked for a postponement will be taken over [*intervenidas*] by the Secretaria de Hacienda; meanwhile loss of title may be declared by the Secretaria de Fomento. For this purpose, a list of all the properties so sequestrated will be furnished by the department of Hacienda to that of Fomento.

IN the Butte & Superior Mining Company's quarterly report a reference is made to the use of more than 1% of oil on the ore being treated in the flotation mill. It is stated that the entire plant has been running "for considerably more than a month at normal tonnage and using 1% of oil or more, uniformly throughout all flotation operations. The results of this modified practice have been and are satisfactory in all metallurgical respects. The increase in cost of oil-supply is not a serious item when compared to the royalties which the owners of the patents in litigation exact for the use of their process in the treatment of similar ore." To this we may add that the Elm Orlu Mining Company, operating next-door to the Butte & Superior, pays 84 to 88 cents per ton of concentrate to Minerals Separation, the royalty being 2 cents per unit above 8% in a concentrate assaying 50 to 52% zinc. This, on a 2.6:1 ratio of concentration, is

equivalent to about 35 cents per ton of crude ore. Evidently there is a handsome margin for the cost of more oil. The loss of oil is about 13 pounds when using 22 to 23 pounds of it, but it is to be expected that this loss will be decreased as experience is gained in the use of the larger proportion. The Butte & Superior mill is recovering over 90% in a 48% concentrate. Such results are not restricted by the use of a particular kind of oil; on the contrary, any of the oils commonly employed in flotation will serve equally well. Moreover, the use of more than 1% has proved so beneficial in the treatment of certain mill-products in the Chino, Ray, and Utah plants that the management would not return to the smaller proportion heretofore adopted even if the patent embargo were not threatened. Metallurgically, the employment of more than 1% of oil has now been proved so complete a success as to relegate the so-called 'critical' proportion to the limbo of absurdities. The use of 1% or of 0.1% is merely a matter of economy.

DISCUSSION this week begins with an inquiry from Mr. M. G. F. Söhnlein, a metallurgist now resident in Bolivia, to whom we owe an interesting letter appearing in our issue of June 24, 1916. He wants to know how to obtain sulphur from pyrite and we give gladly such information as we have. The question of sampling large masses of low-grade ore, of irregular enrichment, is discussed by our Mr. Storms. He describes two instances in which ordinary sampling by moil was at a discount apparently. We shall revert to the subject at an early date, and meanwhile invite further discussion from engineers, particularly those experienced in the sampling of large mines. Mr. A. W. Allen, whose writings are well known to our readers, and who has recently returned from Uruguay, replies to Mr. Drucker's enquiry concerning the Krupp type of ball-mill. To Mr. J. F. Mitchell-Roberts, a metallurgist associated with Korean mining operations, more particularly the Seoul Mining Company, we owe a note on the action of caustic soda in flotation. He opens up some questions concerning the coagulation of colloids and their de-flocculation that are still in the twilight zone of physical chemistry. We should be glad to hear from Mr. E. E. Free on this problem. The difficulties met by the poor prospector in obtaining correct assays and reliable determination of minerals are not exaggerated by Mr. J. F. Williams, who writes breezily on the subject. In the West determinations of minerals may generally be had without cost by sending samples to the State mining schools. Assays are a different matter. In every district the trustworthy assayers are generally well known. Given equivalent samples no serious discrepancies will be found in the results from different laboratories. The error is apt to be on the side of sampling. Instruction in this art would constitute useful extension work by the mining schools. From a 'Tramp Mill-man,' who has kept an open eye on mining during his useful peregrination, we obtain a suggestive and humorous analysis of the psychologic effect of pitting man against man in rivalry for special rewards. He is right. Co-operation, not strife for personal preferment, should be sought in organizing a working force in mine or mill. The growing custom at large properties of holding weekly assemblies of employees for discussion of practical problems arising in their work is stimulating and gives the individual an opportunity to indicate his worth. This practice deserves to be more generally followed.

Imports of Australian Zinc

Readers of our Eastern metal-market page will have noticed frequent reference during recent months to a mysterious shadow overhanging the zinc market. Producers have displayed anxiety to sell whenever quotations showed an upward tendency. Early in January offers of the metal were made at figures so low that buyers treated them with suspicion. On January 10 it was stated that a broker offered January delivery at 9.25, February at 9, and March at 8.75c., St. Louis, and more zinc was forthcoming at those prices than was wanted. The next day selling was still more active, causing a decline of ¼c., and the offerings were made openly by a firm with alleged German affiliations. It was suspected that German interests were seeking to unload at advantageous prices; but the New York brokers were evidently on the wrong scent. A shrewder approximation to the truth was gained in the conclusion of our correspondent from analysis of market conditions, that "Joplin ore—now quoted around $90 per ton—is not fixing the price of zinc, but zinc is fixing the price of the ore." The virtual retirement from the market of one heavy buyer of ore and concentrate would suffice to bring about the condition existing. It became known at this time that the United States Steel Corporation was seeking zinc material for its smelter at Donora, in Pennsylvania. The building of this battery of furnaces with a total of 9120 retorts was one of the metallurgical surprises of 1915-'16. The plant was more solidly constructed than are zinc furnaces generally: the erection was an example of the celerity characteristic of the housing of 'war-brides.' Ground was broken on October 20, 1915, and the fires were lighted on March 31, 1916. Here was a brand new smelting capacity of 100,000 tons of ore, or nearly 40,000 tons of metal, per annum, suddenly added to the country's zinc-producing equipment. The threat of an invasion of the spelter market by Anaconda, with designs to meet a post-bellum price of 5c. per pound even if electrolytic zinc should then fail to command a premium for purity, had not been taken seriously enough to affect the situation. Butte & Superior was a more disturbing element. The United States Steel has recently been negotiating with that company for zinc concentrate. It may seem like a long haul, but it is no more surprising than the solution ultimately reached for supplying the retorts at Donora. The Butte & Superior, however, was involved in other plans. Originally its output was contracted to the American Metal Company, which is the representative in this country of the Metallgesellschaft

of Frankfort. This contract called for a certain minimum output, and conceded an option on the maximum. Failure to exercise the option set the Butte & Superior free to deal with the United States Steel if it chose, but instead of so doing it is now understood that it has contracted its excess product, amounting to over 100,000 tons annually, to the American Zinc, Lead & Smelting Company, controlled by the same interests as the Butte & Superior. Not only was this concern contemplating expansion of its own, which precluded the sale of concentrate to the United States Steel, but it had taken options on 4300 acres of land in south-eastern Kansas directly north of the Eagle Picher Company's ground in Oklahoma. A subsidiary organized under the name of the Miami Zinc Syndicate has been keeping 15 churn-drills busy testing that field for several months.

No other large tonnage of zinc ore or concentrate being available for the Donora smelter, the unexpected has happened. The United States Steel Products Company, a subsidiary of the Steel Corporation, has been importing large quantities of zinc concentrate from Australia for the past three months. One consignment of over 6000 tons passed through San Francisco last week. At this rate it would appear that practically the total capacity of the smelter can be supplied from that source. The Broken Hill concentrate averages about 47% zinc. Thus the estimated annual output of 40,000 tons of spelter would be slightly exceeded by the average of 6000 tons per month now coming forward. The disturbing factor in the Eastern zinc market is hereby largely explained. Joplin was counting on an expected demand that had been eliminated. No one would have suspected Australia of entering the American field as a competitor of the Mississippi Valley zinc-districts, especially with ocean-freights soaring to such unprecedented heights; but a great corporation can overcome the obstacles that are insuperable to smaller fry. Moreover, the possibilities of reducing the cost of a 3000-mile haul across the continent, after the Union Steamship Company of New Zealand had landed its cargo at San Francisco, might have failed to appeal to those who had not ascertained the open-minded attitude of the Southern Pacific and Western Pacific railways, which were unbound by published tariffs on zinc ores and concentrates. This is an interesting example of the complex circumstances of metal production, enabling material to be diverted far from the course that would seem logical. The fact that the Steel Corporation, through its subsidiary, the American Steel & Wire Company, consumes its own output of spelter, and needs to be free from the dominance of the metal-sellers, explains the first step in the erection of a great zinc smelter. It may even have been erected without certain knowledge of its ultimate persistent source of raw material, as is now indicated. That it required zinc and that it had cheap fuel in unlimited quantity were enough. There are always opportunities to get what one must have; no man or group of men controls the whole of any needed article. The United States Steel Corporation even now may be looking for nearer sources of zinc; but it is most improbable that a short-term contract for heavy monthly shipments of Australian concentrate to this country would have been made; the indications point toward an important attraction to this country of the industry of smelting and refining the zinc products from Australia, formerly absorbed by the Belgian and German smelters.

The Consulting Engineer

Mining has need of service from many kinds of men. Among them the consulting engineer takes a place peculiarly responsible and calling for the most intense application not only of scientific acumen, but of character. In modern days, when mining enterprise involves the spending of princely sums of money and the direction of whole armies of men, it is to be expected that the technical advisor to the management shall be specially endowed with mental and moral vigor. That will have been made manifest in the several interviews that we have published with men belonging to this branch of the profession. Time was when the manager of the mine and the company's consulting engineer acted toward each other like the typical bishop and the dean, each jealous of the other's prerogatives and keen to detect any trespass on each other's authority. All that is changed; the childish frictions are absorbed in the sense of big work and the need for hearty co-operation. It has been discovered, however, that the essentially critical pose of the consultant must have for its background some measure of previous experience in managing mines. The consulting engineer must graduate from mine management and not from the class-room or from the stope. In reviewing the careers of our leading consulting engineers, we find that they have served this necessary apprenticeship. For instance, in the interview with Mr. Thomas H. Leggett, appearing on another page, it will be noted that he underwent this essential preparation, after a good training at the Columbia School of Mines. He acknowledges the benefit of the grounding in mathematics that he owed to Van Amringe and in doing so he confirms our idea, expressed on another occasion, that the success of the Columbia men of an earlier generation was due largely to the mental discipline of a rigid mathematical training. Like many other capable men, Mr. Leggett did several kinds of work before he found the opportunity to prove his worth; but all of it counted, we may well believe, in the development of the qualities of keen observation, clear thinking, and intellectual honesty that contribute to the making of the real consulting engineer. Life on the frontier, with its stage-coaches and Apaches, is now almost a thing of the past, at least north of the Rio Grande, but south of that boundary there was, 37 years ago as there is today, all the uncertainty of life and property that the most adventurous might wish. Mr. Leggett is one of many that have found Mexico a post-graduate school. Batopilas and Santa Eulalia are still names to conjure with, and the mention of John C. F. Randolph recalls an American engineer that upheld the highest traditions of

the profession. Then came the Rosario, in Honduras, a great mine and a long-lived producer of the precious metals. A 35th anniversary and a 197th dividend prove that some mines last as long as one of the generations of men. Another outstanding engineer crossed Mr. Leggett's trail in the person of Mr. Walter McDermott, formerly identified with Fraser & Chalmers and now associated with honorable and efficient management of large-scale mining affairs in London. At the Darien mine, on the Isthmus, Mr. Leggett had a chance to show his mettle and to get malaria into his system, as later in Honduras. He also demonstrated his resourcefulness under difficult conditions. Then came Bodie and the Standard Consolidated, a mine that has served to train a number of good men, both in mining and metallurgy. Besides Mr. Leggett himself, the Standard served to prepare Charles A. White, Charles W. Merrill, R. Gilman Brown, F. L. Bosqui, Theodore J. Hoover, R. Chester Turner, and E. H. Nutter. The metallurgy at Bodie covered some of the earlier chapters in cyanidation, and the introduction of electric transmission was another event of far-reaching consequence. In both these departments Mr. Leggett showed that he possessed a mind hospitable to new ideas and able to form correct technical judgments. Then came a wider and bigger opportunity in South Africa. Of this he made good use, winning a reputation, and taking his place among the leaders of the profession. Experience accumulated in divers regions had given him initiative and knowledge for taking his part in the development of the greatest goldfield as yet uncovered by the miner's pick. He places emphasis on the give and take, the exchange of ideas, and the professional solidarity of the American and British engineers then directing the rapidly growing operations of the Rand. He does not say much about the difference of opinion arising from the Jameson Raid and the Boer War, but we happen to know that Mr. Leggett took the unpopular side, and as a democrat his sympathies were with the Boers in their struggle against big odds. He may have underestimated the force of events, the political necessities that ensued, and the inevitableness of the conflict of ideas in his sympathy for a small people that strove to maintain independence and the right to live in their own way. He stood manfully for his ideal, and for that he was respected by those who disagreed with his inferences. Such courage to think for himself is characteristic, and in the end it evoked more of respect than of antagonism. In him loyalty to ideals went with the other loyalties—to his employer, to his friends, to his home. He has never been afraid to speak out, and he has always been willing to give advice or assistance to any man that asked it of him. His helpfulness to others will be recalled by many that will read these words. The remarks on Rhodesia tell an unpalatable truth. The larger part of Rhodesian mining was always done in London: the dealings in paper have been given a greater importance than the digging of ore, and for that reason Rhodesia stands today as one of the most striking examples of over-capitalization, shady promotion, and unscrupulous finance. Mr. Leggett does not say all this, but he shows his dislike of the queer doings that the Boers call 'vernukerij.' Near the end of the interview he gives a bit of useful advice to the younger engineers: not to think so much of an increase of salary as to strive to obtain an increase in experience. After all, the one kind of capital that is indestructible—as long as life lasts, and longer if it goes into print—is a knowledge of men and things. At the beginning of a career it is well for the young man to see and learn as much as he possibly can in order to equip himself for the larger opportunity that comes later, often unexpectedly. Mr. Leggett's modest replies to our catechism show how great is the variety of experience that goes to the making of a thorough equipment for consulting work. We venture to add that his record illustrates the fact that it is well to avoid, if possible, going to malarial regions. A young man does foolishly in selling his birthright, good health, for a mess of pottage—increased pay. Nothing can quite compensate for the joyousness of perfect health. We say that because Mr. Leggett's many friends know that much of his most effective work was done when under the handicap of malarial depression. That he overcame it sufficiently to accomplish so much is a tribute to his strong character and to a courage not simply physical. One who knew him at the Rosario mine tells how he 'caught up' some dangerous ground with the help of natives where experienced miners from Colorado had been afraid to venture. With such personal courage goes the power to lead men and to hold them in loyal service. We know that those that have worked under this engineer have an affectionate respect of which he may never have been aware, until now. Does he remember the burly mine-foreman that he ordered out of his office on account of a failure to show ordinary courtesy, and how the man slunk away cowed by an outburst of righteous anger? Such courage was moral rather than physical. It is the quality that an engineer needs to preserve his intellectual honesty and to give unbiased judgment. That quality Mr. Leggett has exhibited in his appraisal of mines. He realized long ago that mining is a business, and that the object of examining a mine is not to determine the genesis of the ore-deposit nor to fuss over the extraction of the last 3% of the metallic contents of an ore—although he knows full well the proper importance of such correlated matters—but to ascertain whether the mine will be a source of profit to those that exploit it. Of this ultimate purpose of mining he never loses sight. He is able to discard the immaterial and to arrive at the conclusion whether a given mine is, or is not, worth the money asked for it, that is, whether having purchased it at that price, it will yield a sufficient profit in a sufficiently short time. These may be truisms, but they have become so mainly in consequence of the opinions expressed and the work done by such men as the subject of this sketch. In him Columbia finds another distinguished exponent of her fine traditions and the profession an exemplar of the code that becomes the scholar and the gentleman.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Sulphur From Pyrite

The Editor:

Sir—In the December 23 issue of your valued paper I read on page 919 that sulphur production from Mount Lyell pyrite has been proved feasible. I have been very much interested in the possibility of recovering sulphur from pyrite for the reason that at the principal Bolivian silver mines the ores are treated by chloridizing roasting followed by leaching with sodium or calcium hyposulphite, and a large amount of sulphur is used for preparing the precipitant and regenerating the solution. This sulphur is now being imported from Ollaguë in northern Chile, and costs as much as $60 to $80 per metric ton; besides, it is of rather inferior quality, containing only 75% sulphur. The silver ores are mined from veins that frequently contain considerable proportions of practically barren pyrite, which is separated by hand-sorting and left on the dumps.

If a method could be devised to obtain only half of the sulphur contained in the pyrite, that is, the equivalent of the amount sublimed by heating pyrite in a closed tube, more sulphur could be produced than the quantity that is now consumed, and moreover, there would be no more need to import sodium hyposulphite, since it would be cheaper to make calcium hyposulphite locally. The crucial point is, however, the fuel problem. With coal at $50 and crude oil at $75 per metric ton, it is probably cheaper to generate the heat by burning part of the pyrite. The operation could possibly be performed in a multiple-hearth roasting-furnace which has one or more muffled hearths built between the roasting-hearths in the zone of highest temperature.

I wonder if such a process is in use somewhere, or if the work being done at Mount Lyell is along similar lines, and would greatly appreciate some information on the subject.

M. G. F. Söhnlein.

Machacamarca, Bolivia, January 17.

[A small amount of elemental sulphur regularly collects in the cooling-chambers between the pyrite-burners and the Glover tower in sulphuric-acid manufacture. This is noted frequently when the proportion of gangue to the pyrite in the charge increases. Control of the sublimation of sulphur from burning pyrite has proved evasive. Results of the efforts at Mount Lyell are not at hand. A method that suggests itself as applicable under the circumstances present at Machacamarca would be to take advantage of the ready absorption of large quantities of SO_2 in a strong solution of sodium sulphite. The absorbed SO_2 is combined with barium by causing the sodium bisulphite to act upon $BaCO_3$. Carbon di-oxide is evolved, and barium sulphite precipitated. The barium sulphite is collected, dried, mixed with a small amount of crushed coal, and heated to redness. By this treatment it is reduced to BaS, which can be leached from the cinder by water. The carbon di-oxide from the previous reaction is then passed through the barium-sulphide liquor, regenerating the $BaCO_3$, and giving off H_2S. Conducting the latter gas into a tower packed with quartz or other inert material, and meeting SO_2 from the pyrite-burner, the mixed gases then rising through the tower and meeting a downward trickling solution of calcium chloride, the sulphur is precipitated according to the reaction

$$2H_2S + SO_2 = 2H_2O + 3S$$

The $CaCl_2$ does not enter into the reaction, but appears to be necessary to effect complete precipitation of the sulphur. It may be worth while to suggest that the above process may be started by using common barite in the first instance, reducing it to sulphide by heating with coal, leaching and converting to carbonate with CO_2 generated in any convenient way. While the process is theoretically regenerative there is, of course, a small loss of barium in each cycle, which must be made good.—Editor.]

Difficult Mine Sampling

The Editor:

Sir—The sampling of mines is never an easy task, and sometimes it is most difficult to obtain samples that correctly represent the value of the vein at the place the sample is taken. Several years ago I had occasion to examine and sample a mine on Mount Gleason, in Los Angeles county, California. The formation was anorthite, in which the quartz occurred as a series of lenses that succeeded each other both in strike and dip. Between the lenses the walls came together, the course of the vein being indicated by a mere seam. From this veinlet the quartz swelled to a width of 7 ft. The lenses were seldom more than 20 ft. long. An adit had been driven on the vein, and at that level the ore was partly oxidized, and the quartz somewhat corroded, as if by some strong solvent. Pyrite was the only sulphide mineral observed, and this showed the evidence of oxidation, though there was little iron oxide. There were many cavities in the quartz, due partly to corrosion of the silica, and partly to the removal of some of the pyrite by solution. In many of these little holes that honey-combed the rock

there remained some loose granular pyrite, sulphur, and metallic gold. There was also some gold in the solid quartz. The quartz was hard, and when an attempt was made to sample the vein, at once the pyrite, sulphur, and gold fell from any holes that were exposed, thus 'salting' the ore as it was broken down. With the use of either pick or moil the same thing happened, for, if a trench but four inches wide were cut across the ore, gold, pyrite, and sulphur would be jarred loose over a width of a foot or more and fall on the canvas. The only safe thing that could be done was to take a large sample over a width of four feet, and even then it was not really representative, for the same reason as before, though in a less degree. Another instance that came within my personal experience was the sampling of a mine in the Colorado desert, about 20 miles from Yuma. There, also, the quartz was hard, but there were numerous seams of finely crushed material, which carried most of the gold. Only large samples could be depended upon, and these had to be discounted as a factor for safety. To me it seems that the only safe way to determine the number of raisins in this sort of cake is to feed it by the ton to a properly equipped mill.

W. H. Storms.

Berkeley, February 20.

Wet Crushing in Krupp-Type Ball-Mills

The Editor:

Sir—In reply to A. E. Drucker's enquiry, in your issue of February 10, I would refer him for full details to a short article of mine that appeared in your issue of March 7, 1914. I also submitted further data, which were published in a lengthy paragraph in the issue of April 4, 1914. The latter was illustrated.

After an erecting and operating experience with this type of mill in Mexico I was enthusiastic about the excellent results obtained, and I can only presume that the design has not been imitated to any extent by reason of its somewhat complicated construction. I do not know of any other wet-crushing mill where such ample provision has been made for the immediate discharge of material ground to a definite size; where reduction is accompanied by trommel-classification, and where the oversize is automatically returned to the interior of the mill for further grinding.

My notes give me the following data:

Size of mill	5 ft. diam.
Screening used	20 by 20 mesh
Feed size	1½ in.
Horse-power	20
Capacity, tons per 24 hours	60

The extra cost of wear and tear of liners and balls, when comparison was made with the dry-crushing mill, was more than compensated by the increase in tonnage, with practically the same expenditure of power. The duty was maintained on an exceptionally hard rock, carrying an appreciable amount of flint, a fact that will explain the advisability of a comparatively small-sized feed. The mill operates with least attention on a uniform grade of material, both as regards size and characteristics, and it was found imperatively necessary to keep the water in the cone-discharge at the adjusted level.

A. W. Allen.

New York, February 17.

Caustic Soda in Flotation

The Editor:

Sir—In your issue of February 17, Mr. C. S. Parsons discusses the action of caustic soda in flotation. I quite agree with him that the first action of the caustic soda is probably to deflocculate the colloidal slime in the ball-mills immediately the ore and water come together. By the time the pulp arrives in the primary Dorr classifiers there is a distinct evidence of flocculation having taken place, the surface of the overflow closely resembling curdled milk, being made up of slime-flocks. So far as present investigations have gone there appear to be few mineral particles in the colloidal slime in the ore, but without the addition of caustic soda the colloidal slime appears to have a greater affinity for coating the mineral particles than does the eucalyptus oil. As the ore at Tul Mi Chung averages nearly 40% limestone, the use of acid is prohibited.

The addition of caustic soda to the circuit has entirely altered the settling properties of the pulp, the calcitic slime-aggregates or flocks remaining in suspension long after the other solids have settled out. To such an extent has this been the case that whereas in former tests an allowance of six square feet per ton per 24 hours to obtain a clear overflow from a Dorr thickener was sufficient, 36 sq. ft. is necessary after the addition of two pounds of 72% caustic soda per ton of ore, in a pulp having a dilution of three parts water to one part of ore. The above conditions vary slightly with the class of ore being milled.

J. F. Mitchell-Roberts.

San Francisco, February 20.

The Prospector Again

The Editor:

Sir—Having read the several contributions on 'What is the Matter with the Prospector,' I will give my views. I say that nothing is the matter with the prospector, except his head, for still following the game. The trouble lies with capital that seeks to kill the goose that lays the golden eggs. I will give my own experience during the past six years. I am a prospector, not a miner, nor a promoter of stocks or of wild-cat schemes. I have, so I think, several good prospects of vanadium, ozokerite, gold, silver, copper, and tin. My first experience was with a tin prospect, four years ago. I found an 8-in. vein, the finest specimen of zinc ore I ever saw. I sent it to an assayer, and it ran $75 in copper, lead, gold, and silver. I sent a sample to the smelter, and returns came back about $26. So I dropped it, and

went to work on a big vein of gold and silver close to this property, and accidentally got an assay of $2000 per ton from a picked sample. This fall I thought I would need the ground where the zinc ore is, so I made a location, not for the copper or gold in the 8-in. vein, for it would not pay, but to have the ground for a dump and a mill-site—we had mineral in place. A friend in Omaha sent for a sample of this ore, and he was sure it was zinc and as he wanted to get in close to this big strike cheap, he had the sample run. After he learned that we had the ground, he sent the assay to me, showing 37% tin. I sent a sample of my vanadium ore to an assayer, and he gave me $30 per ton. I sent another sample to the Primos Chemical Co., and they reported testing for vanadium, uranium, molybdenum, and tungsten, but did not find anything of commercial value. So good-bye to that. The ozokerite had too much paraffin, so good-bye again. I took a sample of 50 pounds and pounded it fine. I cut this sample from 14 ft. of ore taken across the face, sent 10 lb. to a smelter and got about $24; 10 lb. to a big mining company, and got $20, but the company wanted to send an expert at once to look it over. I quartered down six 8-oz. samples of this same ore, sent one to an assayer at home, got $4.20; one to another, got $16; one close to the smelter and got $12.60—all from the same sample. I sent one to New York and got $67.20; one to Victor, Colorado, and got $42.20; and one to a man at Durango, and got $726. I had this examined by an engineer, and he took 14 samples from the property for his company and the highest assay was $8, and from that down to 40c. Now, what in hell am I to think? Have I got something, or nothing? I can't buy every tin-horn assayer in this community. I can't pay an engineer for a favorable report, nor can I build a mill and put it to work. Now, a friendly prospector, close to our prospect, struck good ore last year that, according to assays from local assayers, ran from $70 to $280. Finally, by scratching and digging, and by taking in a partner and giving him half of it, they got enough grub and sacks together to get out two narrow-gauge cars of ore. A grab-sample from every sack, pulverized and quartered down to a 50-lb. sample, returned an assay of $80 per ton. They felt fine and made another shipment to the smelter. They got $17 for one car, and $27 for the other. Take your medicine. It's hell, but 'Dr. Guggy' says "Take it." Now what are they to do? Give it away after 10 years of hard work? Here, too, we have got to give ours away after five years of work, unless we get some relief from our Government or the State. With all the articles I have read, I have not seen a remedy suggested to put the prospector back to the hills. I will give you my idea. Adopt this proposal from the Colorado Metal Mining Association; that each county having mineral-bearing ground, equip a high-school, so they can test for any mineral. Hire a first-class chemist; put him under a good stiff bond to give nothing but a reliable analysis, and have any ore found in said county assayed free; have the prospector sign a contract to give a stated percentage of the sale, if any be made, and a royalty from the net profits for a given number of years, according to the amount of revenue obtained from property. Let such laws be put in force and the hills will be so full of prospectors they will be bumping into each other within 30 days. Any man that has the nerve to climb the hills can raise 30 days' bacon and coffee and his Climax; but the finding out what you have after you have found it—that takes the cash. And that's what is putting the prospector out of the game.

J. F. Williams.

Mancos, Colorado, February 10.

The Bonus System in Milling

The Editor:

Sir—The human side of milling seems to have been neglected in the maze of technical discussion of a constantly changing mill-practice. Are the latest ideas in the flow-sheet, or in the most improved machinery, alone a guarantee of highest efficiency and of successful operation? How many of us have seen a ramshackle old mill doing profitable work, while the management of a new plant, equipped with the latest metallurgical fads, has found difficulty in meeting the pay-roll.

Successful milling is simply the intelligent and efficient utilization of the means at hand to secure the most profitable result attainable; not by this means alone, but in the brains and the hands that apply it, lies the secret of successful operation. Given a mill reasonably suited to the work at hand, the human element becomes the chief problem of the manager.

There are mills where men work simply because they are employed, without initiative, attempting no innovation, having no disposition to change existing methods, as wages have been whittled to the minimum. An incentive to improvement is lacking. The workman does as little as he can and still hold his job. Experience has taught him that if he voluntarily does more, then still more will be expected. His main concern is to avoid the displeasure of his immediate superior. Often he has little knowledge of his duties beyond the daily routine, and he cares even less for results. He is being driven, and under such conditions he soon develops those peculiar traits of character that are commonly attributed to the mule.

In other mills the management is more ambitious and offers some sort of reward for the best individual effort, which invariably results in bitter competition and the arousing of personal jealousy, followed by a resort to unfair practices. How plausible it sounds to reward the best individual effort.

Let me cite an instance that came under my personal observation. A bonus was offered to the mill-man showing the highest tonnage crushed, and another to the man that produced the lowest-grade tailing. This looks as though it might have the effect of stimulating the mill-crew. It did. A ball-mill was crushing a soft oxidized ore containing some hard quartz. Under an increased feed—in the effort to secure the bonus for greater capacity—a return oversize accumulated in the mill, and

this, sooner or later, had to be re-ground at intervals, or the feed had to be reduced to the normal capacity of the machine. The day-shift discovered the secret. By skilful manipulation they secured a high tonnage per shift, so gauged as to leave the ball-mill with a heavy load of hard quartz that had accumulated. This it was the duty of the night-shift to re-grind. To do so would necessarily reduce the capacity of the ball-mill and lower the tonnage of their shift, but they met the emergency with a cunning equal to that of their daylight opponents, by substituting a coarser limiting-screen, sluicing the coarse material through the ball-mill into the inadequate classifier, and thence to the cells and tables. This operated to the grief of the man responsible for the tailing on the night-shift, and to the inevitable loss by the company through the disturbed conditions in the flotation-cells, as well as to lower recovery from the coarser pulp. Two hours was often lost before everything could be readjusted for efficient work. Not only was the extraction-man at the mercy of the mill-men, but sometimes he found his froth 'die' suddenly, or start to run, soon after coming on shift; his blower became hot, or his blankets 'dead,' all of which necessitated readjustment, involving the loss of valuable metal, as well as of time and temper.

If a mill-man discovered where an improvement could be made, he kept this knowledge carefully to himself, and applied the idea during his shift, to his own personal advantage in order to win the bonus; and again the company lost through being deprived of the use of the new idea throughout the 16 hours this man was off shift. It was more than hinted that tonnage-samples were increased by the judicious use of a shovel, or by accidentally turning a hose into the sample-bin. When the ore-bin was low, the fine was shoveled forward to the gate, leaving the coarse for the next shift. It was common practice to remove the tailing-sample can from the automatic sampler when starting-up after a shut-down, or, in fact, during the continuance of any unfavorable condition, and under the circumstances these occasions were too frequent. Samples were so cleverly salted against an opposing shift that one man used to cut-down and dry his own samples. He left behind a reputation for making a low tailing.

Thanks to a piece of oily waste, an unfortunate cell-man had his froth die just as a distinguished inventor and metallurgist reached his part of the mill. Of course, the appearance of the waste at this critical moment was scarcely accidental.

The manager of this mill deluded himself into believing that he was securing a high efficiency through the offer of a bonus. In fact, the company was losing many times the amount of the bonus offered through the competitive tricks of men on the various shifts in their censurable efforts to win the reward. Besides, there was created a personal bitterness between the men that was conducive to anything but the best work.

In another mill where the personal bonus system was attempted, it led to such unfriendly rivalry that the samples became absolutely unreliable and the idea was abandoned. The individual bonus is a step backward and loses all of the advantage that may be derived from co-operative effort. In decided contrast to this is the mill where no individual bonus is paid, and where the mill-crew is working as a harmonious unit. There a spirit of good fellowship prevails, and each man endeavors to leave affairs of his shift in a little better condition than he found them. Any difficulty arising in operation of the mill during a shift is freely discussed with the men just coming on, at the change of shift. Each man employed there is interested in the results obtained by the mill as a whole. There is a constant effort made not to beat the other fellow, but to improve the results of individual work wherever possible. Such self-criticism is the first step toward greater achievement. Each man feels free to make suggestions that he considers helpful, and he thus attempts to satisfy the constructive instinct—a feeling that each man has a part in the work —so necessary to arouse in the men.

It is surprising how men who are apparently hopeless cases will respond and develop under a little personal responsibility, with tactful encouragement. The spirit of helpfulness, and of co-operative effort, is applied to the mill as a whole, and usually with excellent results.

At this last-mentioned mill the superintendent and two of the shift-bosses were formerly employed at the mill where the bonus system had been in vogue. Between men of the same trade there always exists more than a sufficient amount of personal rivalry with its resultant consequences. The problem is how to direct that energy, which may be wasted, into a united effort toward a common goal. Where the best results depend so entirely on effective team-work, as it does in a mill, any proper means that may be introduced to bring about this condition cannot fail to be beneficial. A reward for personal effort is admirable, provided the result, as affecting the whole, is considered. If a bonus is to be paid, it should be divided among all concerned, to the end that the men will strive against themselves as a body, and not against each other as individuals.

TRAMP MILL-MAN.

Nogales, February 4.

THE STEAM-SHOVEL was first applied to mining of copper ore, as far as we know, at the Granby mine in British Columbia, in 1903, a reference to which will be found in the MINING AND SCIENTIFIC PRESS of December 26, 1903, where a shovel was used in an open-cut and later was similarly employed underground. The steam-shovel was used, however, in iron mining in Michigan and Minnesota long before that. The use of steam-shovels in the disseminated copper mines of the West and South-west is an important factor in the economy of their operation.

GOLD to the amount of $9,000,000 was recently received from Canada at the Philadelphia mint, for the account of J. P. Morgan & Co., bringing total imports from all sources this year up to $151,000,000, and total imports since January 1, 1915, to $1,288,500,000.

The History of Flotation

By T. A. Rickard

Introduction

The various flotation processes depend upon the successful application of a number of physical principles, of which three may be instanced as underlying the methods successively invented.

1. Film-suspension. This is typified by the floating of a needle on water. In the familiar experiment a small needle is greased, either intentionally or by the natural oil on the fingers; but when pains are taken to prevent contact with anything greasy, the needle will still float, if not too large and if carefully manipulated.* If the needle is too large it will not float, no matter how skilfully handled, because the force of gravity overcomes the force of surface-tension, which is the cause of this kind of flotation. Surface tension is the force that causes the surface of a liquid to resist rupture. This, in turn, is due to the fact that the molecules at the surface have a greater coherence than the molecules within the body of the liquid. In consequence, the surface acts as if it were an elastic film.

2. Oil-buoyancy. This is a simple manifestation of gravity, whereby an oil, being lighter than water, will rise to the surface of a pulp and carry with it any mineral particles that have become immersed in it. The oil plays the part of a raft or boat. In order to effect flotation the volume of oil must be such that its smaller specific gravity will overcome the greater specific gravity of the burden it is to bear to the surface. Most oils have a specific gravity of about 0.9, as against the 1 of water; therefore the flotative margin is 10% only. If the specific gravity of a mineral is 5, then the volume of oil required to buoy it must weigh more than 20 times as much. When an ore contains 4% of a mineral having a specific gravity of 5, then more than 1600 pounds of oil will be required to raise the mineral in a ton of ore to the surface of the pulp. It remains to add that oil exhibits a preference for certain kinds of metallic particles, so that it attaches itself readily to them, while passing the particles of gangue. The latter, therefore, are quickly wetted by the water, and sink. The oiling of the metallic particles enables them to resist wetting and lessens their specific gravity so that in the presence of sufficient oil they are enabled to float.

3. Bubble-levitation. This phase of flotation depends upon the aid of bubbles of gas, which, by attaching themselves to particles of mineral buoy them to the surface, like cork-belts or the bladders that children use when learning to swim. Various gases have been tried, but air is now generally used for the making of bubbles. The attachment of the bubbles to the metallic minerals in preference to the gangue is due to an affinity or selectiveness, like that of the oil, and the presence of oil is said to enhance it. The fact is observed, the theory to explain it is incomplete.

In order that the bubbles generated in, or introduced into, a pulp may perform their metallurgic function they must last long enough to carry their freight not only to the surface but over the edge of the containing vessel. They must not burst untimely. This necessary prolongation of bubble-life is effected by lowering the surface tension of the water, of which their envelope or film is composed. The bursting is due to the contractile force of surface tension, and it must be moderated if the bubble is to last long enough. A decrease of surface tension is produced by putting some impurity or contaminent in the water. Heretofore oil has been the contaminent chosen, as soap is used by a school-boy to blow his bubbles, he having discovered that the bubbles blown in pure water are too fragile for his play. The use of oil was inherited from the prior art, but other re-agents are likely to be found adequate for the purpose.

Thus the third and most successful phase of flotation has grown out of the second, although it is more nearly the logical development of the first phase. Film-suspension involves the aid of air, for the floating of pulverized minerals on the surface of water is helped by the air entrained in the ore. The attempt to invent an effective method out of oil-buoyancy instead of film-suspension goes far to explain the delay that marked the development of this metallurgic process.

Early Attempts

The story[1] of the slow and toilsome development of this metallurgical process may claim to be 'historical' if only for the fact that the use of oil for collecting metals was mentioned by Herodotus. The recovery of gold from the mud of a lake by means of feathers daubed with pitch and held in the hands of apocryphal virgins is as pertinent to the subject as the yarn, 2000 years later, of a young school-teacher in Colorado who was washing oil-stained ore-sacks in her brother's assay-office when she noted that the pyrite floated on the water contaminated by the oil. We know now that the Carrie Everson fabricated in the course of litigation is a myth and

*'The Flotation Process.' See 'Simple Problems in Flotation,' by T. A. Rickard. Page 357.

[1]This article is intended as a chapter in a book on flotation now being prepared for early publication; the attempt at a historical sketch is published now in the hope that attention will be called to any errors in the story, so that corrections may be made before publication in the book. The author will be sincerely grateful to any reader that will take the trouble to suggest necessary corrections.

that, while there was a lady of that name, she was the wife of a Chicago doctor, in collaboration with whom she devised a method based on "the chemical affinity of oils and fatty substances for mineral particles"[2] and obtained a patent in 1885. She and her husband did ascertain that "acidification of the ore-pulp is necessary for the sharp oil-differentiation of mineral from gangue."[3] But the method patented by her in 1885 was a complete failure as a metallurgical process, although it probably did serve to suggest some of the later investigations and it was used freely in the attempt to disprove the originality of subsequent inventions. The odds were greatly against Mrs. Everson: she was a woman, her idea seemed absurd, she had no mechanical ingenuity herself nor was any at her command, and she had no financial backing. If we consider these circumstances, we shall not wonder at her failure to develop a concentration process.

The first patent employing oil for a metallurgical purpose was that obtained by William Haynes in England in 1860. This is of academic interest as being a prelude to flotation. By mixing coal-tar and resin with crushed ore, in the proportion of 5:9, he made a "dough" that held the metallic particles, while the gangue was removed by the help of water and "frictional trituration." The idea proved wholly impracticable and is only worthy of mention as the first recorded use of oil—an oil partly soluble—in the concentration of ores. The next attempt is that of Hezekiah Bradford, an American, who, in 1885, two months before the date of Mrs. Everson's patent, obtained a patent for the first method that was based upon a recognition of the surface-tension of water in contact with air. His method was one for "saving floating materials in ore-separation," such as escaped from arrest by tables, vanners, and jigs. He stated:

"These floating particles appear to possess some peculiar quality which repels the water from their surface, especially when such particles are exposed even momentarily to atmospheric air, and when such exposure takes place the water is repelled from a sufficient portion of their surfaces to cause such particles to float off on the surface of the waste water from the other particles that sink in the water."

He had the germ of an idea pregnant with metallurgic possibility, but it was still-born. Haynes and Bradford had inklings of the physical phenomena underlying the flotation process, but they were pioneers that blazed no trail and crossed no range of fruitful discovery. Carrie J. Everson comes next in point of time. Her groping after a practical process is noteworthy by reason of the introduction of acid, but her trail also stopped at the foot of the talus on the slope of the range. The patent records disclose other abortive attempts in the same direction during the ensuing decade, but none is of any consequence except H. L. Sulman's British patent of 1893, in which he describes a means for saving 'float' gold by adding something to the mill-water that will diminish its surface-tension. This is interesting as recording scientific curiosity concerning the physics of flotation on the part of a metallurgist that was destined to contribute so greatly to the decisive development of the process. His successful participation is due, in part, to his having been formerly engaged professionally in the chemistry of the oil and soap industries, for thereby he acquired knowledge of a kind that proved of great value to him at a later date.

So far no workable method had been invented—only ingenious schemes and impracticable proposals.

The next incident is this story brings us to the edge of real achievement. In 1894 George Robson, for himself and Samuel Crowder, patented a process for separating sulphides from gangue. He disclaimed "the use of acid or salts and also the method of washing away the gangue with water," and appears therefrom to have been aware of the earlier patents. He effected "the separation of the metallic matter by the mixture of oils alone." Thus he followed in the track of Haynes. The proportion of oil was large: as much as three times the weight of ore. It was a method of buoying the sulphide particles with oil. The process was tried on a working scale at the Glasdir gold mine in Wales and was commended by James Brothers, a firm of experienced metallurgists. But it did not succeed and apparently led nowhere. Yet it opened the way for a decisive event, namely, the technical participation of the Elmore brothers.

Elmore

Francis Edward Elmore was a trained engineer with an inventive mind. His father, William Elmore, bought the Glasdir mine from Samuel Crowder, in 1896. The conventional concentrating plant, of jigs and shaking tables, had proved unable to make a good recovery of the gold-bearing chalcopyrite in the ore from this Welsh mine. The elder Elmore sent his two sons, Francis Edward and Alexander Stanley, to investigate. It has been stated[4] by Stanley Elmore that, on the occasion of one of their visits to the mill, his brother Frank noticed copper-pyrite adhering to the oil that had dropped from a shaft-bearing, and thus obtained the idea of his invention: "Finely-divided wet copper-pyrite would adhere to a greasy surface, whereas finely-divided wet rock would not." But no accidental demonstration of the action of oil was necessary to arouse Mr. Elmore's interest in face of the fact that Robson had conducted experiments in oil-flotation on the same spot. We have the testimony of Mr. Crowder himself,[5] now a very old man, that Robson's experimental oil-concentration plant was on the mine when it was purchased by William Elmore, and we know also, from Mr. Crowder, that he wrote to Stanley Elmore in 1897 urging him to use oil as a means of concentration. In 1898 Frank Elmore obtained his first patent. A working unit of full size was erected at

[2]As stated by her son. 'Carrie J. Everson and Flotation,' M. & S. P., January 15, 1916.

[3]H. L. Sulman, Presidential address. Trans. I. M. & M., Vol. XX, page 14.

[4]M. & S. P., September 23, 1916.

[5]M. & S. P., February 24, 1917.

the Glasdir mine. Walter McDermott, Hennen Jennings, and Wernher, Beit & Co. gave the Elmores their financial support and formed a syndicate, which became known as the Ore Concentration Syndicate.[6]

In his patent Frank Elmore describes the process as "Mixing the pulverized ore first with water in considerable quantity, then adding to the mixture an oil of the kind described, which adheres to the metallic constituents but not to the wet rocky constituents." He used a thick oil and introduced the idea of the freely flowing pulp as against the mixing of oil with crushed ore in the presence of only a small proportion of water, as Robson and Crowder had done. By using more water, he also entrained more air, so essential to success, although he did not then recognize this fact.

In the first plant, at the Glasdir mine, the mixture of crushed ore and water was fed at the upper end of a slowly revolving drum, provided with annular helical ribs and transverse blades, so as to mix the pulp and oil without producing emulsification. The oil was introduced through a separate pipe. The mixture was discharged into a V-shaped vessel, where the water and sand subsided, while the oil buoyed the sulphide particles to the top. An oil-residuum of 0.89 specific gravity was used in equal parts by weight with the ore, ton for ton. The oil was so viscous as to require the aid of small rotary pumps to move it forward. The temperature of the oil and water was kept between 54° and 57° F. The loss of oil was 2 gallons per ton of ore. A concentration of 14:1 was achieved with a recovery (in the concentrate) of 69% of the gold, 65% of the silver, and 70% of the copper from chalcopyritic ore assaying 1.12% copper, 0.049 oz. gold, and 0.8 oz. silver per long ton. These details are taken from a paper by C. M. Rolker read before the Institution of Mining and Metallurgy, on April 25, 1900. Mr. Rolker described the process as "somewhat dirty and nasty," but he stated that "the mechanical contrivances brought into action by the inventor are excellently adapted to the work demanded, and bespeak very careful thought, as well as patient, systematic, and highly intelligent work."

The discussion of Mr. Rolker's paper, as recorded in the Transactions of the Institution, shows clearly that nobody at that time recognized the part played by air in the process of flotation. Stanley Elmore has cited the use of a Gabbett mixer, which causes a violent agitation with indrawing of "large quantities" of air,[7] as proof that he and his brother were "quite cognizant of the fact that it was the air entrapped in the bulk of the oil which rendered it capable of carrying more than its theoretical load of concentrate." But this use of the Gabbett machine was made in 1902, by which time the action of air had begun to be understood. During the discussion of the Rolker paper, two years earlier, nobody present had been able to explain why the actual load of concentrate had been 150% more than was accountable to the difference in specific gravity between the oil and the water. The manager, John Bevan, had testified that the floatative efficiency of the oil was 25%, against the theoretical load of 10%, on an oil of 0.9 specific gravity; whereupon Frank Elmore remarked: "It seems rather strange that there should be such a difference between theory and practice." On the same occasion Mr. Rolker said: "The viscosity of the oil is the all-important point." Neither H. L. Sulman nor H. F. K. Picard, both of whom took part in the discussion, made the slightest reference to the agency of air, which was entrained with the ore and water while they were being mixed in the revolving drum. As late as January 1903 Stanley Elmore took out a patent for an improved apparatus wherein air was *excluded* from the operation of concentration by oil. But his is not the only attempt to read the past in terms of the present—all the litigants have done it and many of their witnesses. The fact is clear that in 1900 the agency of air was *not* understood by any of the exponents of flotation.

In 1901 the Elmore syndicate established a demonstration plant in London and the free access thereto given to the mining profession, together with the frequent publication of information concerning the process, did a great deal to stimulate interest and curiosity, contributing thus to the later improvements whereby the process was turned inside-out and made supremely valuable to the mining industry. A number of plants were built to apply the bulk-oil process, at mines scattered all over the world, notably the Namaqua, in South Africa, the Le Roi in British Columbia, the Tywarnhaile in Cornwall, and the Sygun in Wales, but it cannot be said that any one of them was an unquestioned metallurgical success.

At this time the treatment of low-grade complex zinc-lead ore at Broken Hill, and more particularly the beneficiation of dumps of similar material discarded in the course of large-scale milling operations, began to stimulate efforts to add some form of flotation to the conventional concentration process. Hence the next chapter of the story concerns itself mainly with the work of a group of Australian metallurgists.

Flotation at Broken Hill

After various attempts at magnetic separation had failed, an effort was made to employ flotation for the purpose of treating the huge accumulations of tailing, which averaged 16 to 20% zinc, 5 to 10% lead, and 5 to 15 oz. silver per ton.

In January 1902 Charles V. Potter, an Australian engineer, obtained a British patent for the flotation of sulphides in a hot acid solution. He used a stirrer and claimed that the solution would "react on the soluble sulphides present to form bubbles of sulphuretted hydrogen on the ore particles and thereby raise them to the surface." Here we have the first suggestion of the bubble idea. In November of the same year Guillaume D. Delprat, manager of the Broken Hill Proprietary mine, applied for a similar patent, except that he used

[6] In 1905 it acquired the Elmore vacuum patents and became the Ore Concentration Company.

[7] M. & S. P., September 23, 1916, page 452.

salt-cake instead of sulphuric acid. In his first American patent, No. 735,071, filed on January 2, 1903, Mr. Delprat states that his process "depends upon the ore particles being attacked by the acid to form a gas. Each ore particle so attacked will have a bubble or bubbles of gas adhering to it, by means of which it will be floated and can be skimmed or floated off the solution." In another place he says specifically: "The sulphides in the ore are rapidly attacked by the acid and gas-bubbles formed on them, that quickly carry them to the surface." In this and in Potter's patent we have the earliest recognition of bubble-levitation. It is true, we have been told[8] of 'bubbles' being mentioned in connection with an experiment made in 1889 at Baker City, Oregon, where the Everson method was the subject of experiment, but the word was applied to the champagne that was the penalty of a bet, rather than the process itself. A story told in 1915 is apt to read into the happenings of 1889 much that was unknown at the earlier date. Oil and acid were the agents in those futile efforts at flotation made by Thomas F. Criley at Baker City, but it is worthy of mention that the fine grinding of wet ore in the presence of sulphuric acid must have been accompanied by the generation of hydrogen and probably of carbon di-oxide also, if the pulp contained either calcite or metallic carbonates.

Potter and Delprat were mistaken in the reactions that were supposed to follow the introduction of the acid, whether it was the sulphuric, the nitric, or the sodium bi-sulphate that they used variously. At that time it was believed that the sulphuric acid reacted with the sulphides to form hydrogen sulphide without attacking the gangue.[9] Then it was suggested that carbon di-oxide was generated by decomposition of a carbonate encrustation on the sulphides, due to weathering of the ore, arguing therefrom that it was necessary for the gas to be produced at the surface of the sulphide particles. Such explanations overlooked the simple fact that the Broken Hill ore contains a considerable proportion of carbonates, notably calcite, siderite, and rhodocrosite. From any of these a warm acid solution would release the carbon di-oxide gas that promptly attached itself to the surface of the metallic particles.

The processes of Potter and Delprat have been labeled under 'acid-flotation' and 'surface-tension' methods. In their original form, it is true, they did not include the use of oil, and the apparatus pictured in Delprat's patent (U. S. No. 768,035) suggests the surface-tension method of Bradford, but the use of a baffle "to insure the total immersion of all particles of ore in the fluid or liquor" indicates that surface-tension in its simplest form, as used later by H. E. Wood, for example, was not a principal agent. In Potter's apparatus—a pointed box—the feed has to pass under the surface and is wholly submerged, so that surface-tension again is not given free play, although, of course, it is a factor in the formation of the bubbles that buoy the sulphides to the surface after the pulverized ore has been mixed thoroughly with the acidulated water.

In August 1904, Auguste J. F. De Bavay patented a process resembling that of Bradford. He used neither acid nor oil, depending entirely upon the effect of surface-tension to form a film of sulphide particles while allowing the particles of gangue to sink. The company formed to exploit his patents claimed that the process worked without either oil or acid, but it was admitted that the flotation was improved thereby, and both oil and acid were used at a later date. In 1910 his rights were transferred to Amalgamated Zinc, Ltd., and in 1912 this company was annexed by Minerals Separation, Ltd. De Bavay's method was employed on a large scale at the North Broken Hill mine and in a plant for treating the dumps of the South and Block 10 mines. It is also used on current zinc-tailing produced at the North and South mines. Treatment is confined mainly to material free from slime. Indeed, none of the earlier processes, the Potter, Delprat, De Bavay, Cattermole, or Elmore did good work on slime—at Broken Hill.

The operation of some of these Australian methods of flotation without oil is an interesting feature. Most of them treated old dumps and it is well to note T. J. Hoover's suggestion[10] that "there may be organic substances in the ore which, upon the addition of acid, yield gummy organic compounds that selectively adhere to the ore." The research of recent years has disclosed the fact that a large variety of soluble frothing agents are effective and that a number of shrubs yield derivatives capable of replacing oil in the flotation-cell.

In 1903 a Potter plant was erected to treat middling from the lead-concentrator on Block 14. Concurrently the Delprat process was adopted by the Broken Hill Proprietary, the plant being increased successively from its original capacity of 3500 tons per week to 5300 tons per diem. Litigation ensued between these two Australian patentees. This ended in a compromise whereby Potter was eliminated; but it is worthy of note that Potter's method was the first flotation process to be used successfully on a working scale.

In 1905 the Zinc Corporation was formed to purchase and treat several large dumps. In 1906 the Potter process was used by this company on the British Broken Hill Proprietary dump, from which a concentrate was obtained containing 44% zinc, 8% lead, and 8 oz. silver, representing a recovery of 81% zinc, 55% lead, and 55% silver, at a cost, including transport, of 50 cents per ton. H. C. Hoover testified in court that the Potter process, as used by the Zinc Corporation, "proved a commercial failure." In 1907 the Minerals Separation process was adopted in a plant erected under the direction of the patentees, but, as Mr. Hoover says, it "also proved a failure, and after exhaustive trials the Elmore flotation process was adopted and found successful." He refers, of course, to the Elmore vacuum process, which was used by the Zinc Corporation chiefly on jig-middling

[8]Ben. S. Revett, M. & S. P., October 16, 1915, page 590.

[9]'The Physics of Ore Flotation,' J. Swinburne and G. Rudorf, M. & S. P., February 24, 1906.

[10]'Concentrating Ores by Flotation.' Page 101.

from the Block 10 mill, until 1910, when, on the advice of his brother, T. J. Hoover, the improved Minerals Separation process was substituted, because it promised to give better results on slime and because the coarse material of the tailing-dumps had been largely exhausted.

As early as 1902, while working with the granulation, or Cattermole, process in the Central mill, the scum of slime made from re-crushed tailing was saved by floating it over a spitz-box. W. Shellshear and F. A. Beauchamp suggested the application of this idea to correct the failure of the granulating process caused by floccules of mineral breaking away from the granules on the tables. The suggestion was put aside until 1903, when a small spitz-box was tried. It was ascertained that the flotation effect was produced while using 9 lb. oil and 22 lb. acid per ton of ore. The proportion of oil was decreased gradually to 2 lb. per ton. This was the real beginning of froth-flotation.

The first mill to use the Sulman & Picard modification of the agitation-froth process, as recorded in U. S. patent 835,120, was the one at the Central mine, built in 1905, as previously mentioned. In 1907 a new mill was finished and by 1908 the recovery had been improved to 85.5% of the zinc, 82.5% of the lead, and 83.8% of the silver, on a material assaying 21.4% zinc, 6% lead, and 8.6 oz. silver per ton, yielding a concentrate assaying 42.5% zinc, 11.4% lead, and 16.6 oz. silver per ton. Concentration was in the ratio of 7 : 3.

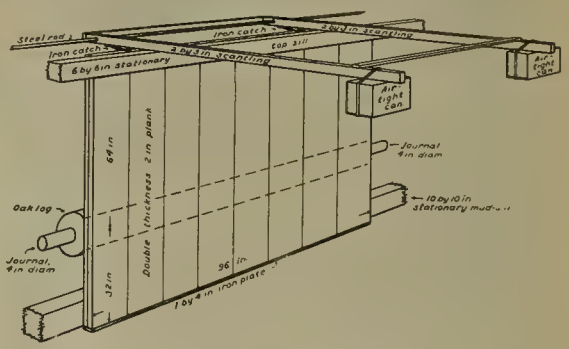
(To be Continued)

The Self-Shooter

Where placer mines lack sufficient water to carry on gravel-washing continuously, either by the sluicing method, or by what is known as ground-sluicing, miners in some localities build what is known as the 'self-shooter,' 'flop-gate,' or 'boomer,' by means of which a small stream of water is made to do efficient service. A dam is constructed across the stream, and a gate is so arranged that, when the reservoir is filled, it automatically opens and discharges. As it rushes out the water is directed by ditch or flume to the working-places, washing the gravel into the sluice-boxes below, which are provided with riffles. The self-shooter, when properly constructed, needs little attention, and the frequency of discharge generally can be regulated to suit the convenience of the miners. The accompanying sketch shows the details of construction of a self-shooter in use near Placerville, El Dorado county, California, designed and built by George Kirchner at his mine. For a description of this we are indebted to Burr Evans. The dam is solidly constructed of a crib of timbers filled with rock and earth, faced with plank and made water-tight. The gate only is shown in the sketch, together with the stationary sill at the bottom, and another timber at the top, the function of which is apparent.

The gate is made of 2-in. planks spiked together, and is provided with a heavy iron plate at the bottom, to overbalance the upper part, as shown. The horizontal axis of the gate is placed about one-third of the way from the bottom of the gate, and consists of a log of oak or other wood 16 in. diam., hewn to a 10-in. face on one side, and solidly bolted to the planks. The bearings at the ends as shown are turned down in a lathe or shaved by hand, and these rest in boxes of either iron or wood that are bolted to the timbers on each side of the gate and between which it swings. These timbers have been omitted from the sketch in order to avoid confusion. It may be explained that an axis of wood is preferable to one of iron, as when made of metal it has been found to spring at the centre under the pressure of the water, unless very heavy.

When the gate is closed the water accumulates in the reservoir, gradually rising until nearly full. The gate is provided with two latches, as shown in the sketch, these being attached to a frame of scantling. Two air-



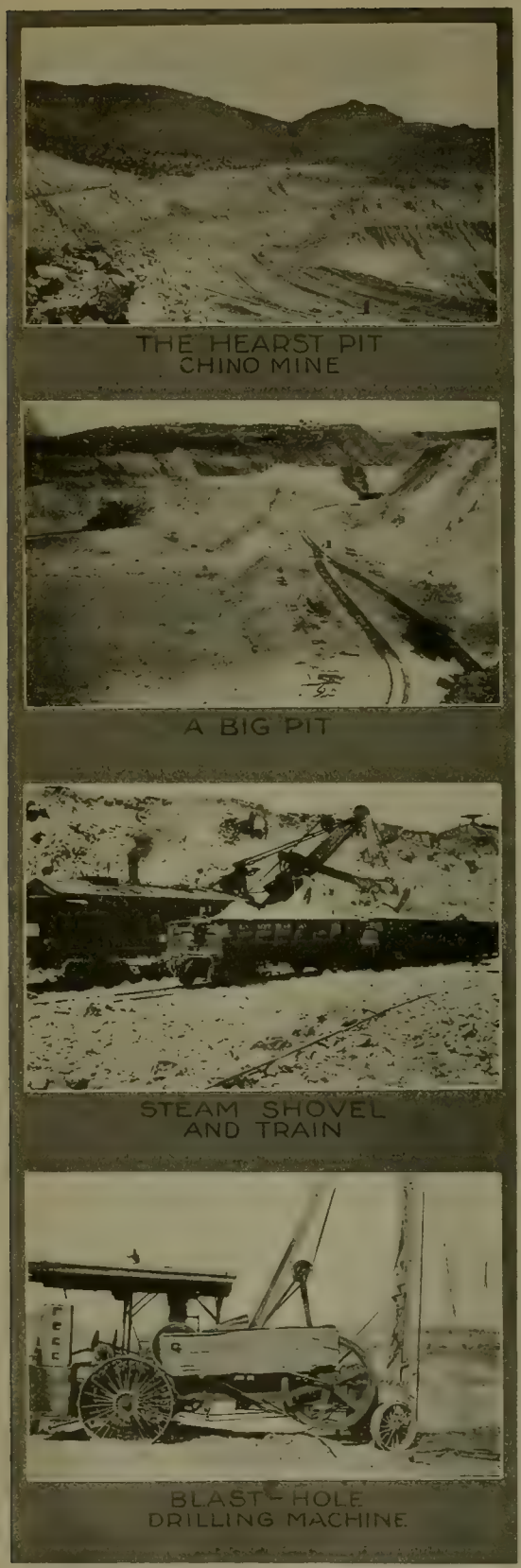
THE FLOP-GATE SELF-SHOOTER.

tight cans are also fixed to this frame, as indicated. When the water reaches the level of the cans they lift the float-frame, thus releasing the latches, and the water in the reservoir flows out.

As the axis of the gate is at a distance of one-third its height from the bottom, the greater pressure from the water is obviously on the upper two-thirds of its surface, which causes the gate to overturn, permitting the escape of the water. When the reservoir is nearly empty, the weight of the iron shoe at the bottom of the gate returns this to a vertical position, the latches automatically falling into place and holding the gate closed until the floats again operate. Thus the reservoir re-fills and the gate automatically discharges at approximately regular intervals. Usually two 5-gal. oil cans afford the necessary buoyancy to start the mechanism.

In some self-shooters, a box is placed on the outer side of the dam into which a quantity of water overflows from the reservoir when it has reached a stated height, and the weight of the water in the box is utilized in opening the gate-latches. The principle is the same in either case. All that most miners require is an idea, as usually they have sufficient ingenuity to arrange a contrivance of this kind to suit their own fancy, and adapted to such materials as are at hand.

SPAIN produced 1,464,349 tons of cupriferous pyrite in 1916, from 45 mines.



THE HEARST PIT
CHINO MINE

A BIG PIT

STEAM SHOVEL
AND TRAIN

BLAST-HOLE
DRILLING MACHINE

The Chino Copper Mine

At the Chino mine, at Santa Rita, New Mexico, all of the ore is mined in large terraced open-pits, by means of steam-shovels. Although the ore is not extremely hard it requires to be broken in advance of the steam-shovels. This is accomplished principally by putting down 'blast-holes' of 6 in. diameter, using churn-drilling machines of the Cyclone type, one of which is shown in the accompanying illustration. The machine is driven by a gasoline-engine, and is equipped with traction-gearing so that it is self-contained and can move from place to place as required. Some of the older blast-hole machines are operated by compressed-air, but these are less satisfactory than those run by a gas-engine. The holes range from 25 to 60 ft. deep. The cost of this kind of churn-drilling is stated to be one cent per ton of ore broken. Before a hole is blasted, it is 'sprung' by exploding several small charges of dynamite in the bottom. The hole is chambered four or five times with an increasingly larger amount of powder each time, the first time with 5 sticks, the second with 10 or 11, the third with 20, and the fourth with 28 to 30 sticks. Generally 40% dynamite is used for this purpose. By aid of a hand-mirror the sunlight can be reflected into a hole to a depth of 15 to 30 ft. and the loader can, in this way, often see to a depth varying from 10 to 30 ft. The hole is loaded for the final blast after it has been chambered sufficiently, which depends on the depth of the bore, the hardness, the tenacity, and the volume of rock to be broken. An average charge for a vertical hole on a terrace of ore is: for a 28-ft. hole, 138 lb. of 40% dynamite; 100 lb. Trojan granulated powder (No. 2). For a 50-ft. hole, 170 lb. of 40% dynamite, and 200 lb. of Trojan No. 2. Deeper holes require a still heavier charge. When the ground breaks irregularly on the bottom, horizontal holes are drilled and blasted to secure an approximately level rock-surface upon which the tracks of the steam-shovel may later be laid. When a blast is about to be fired, the alarm is given by the blowing of the whistle on the steam-shovel. The miners in the vicinity take refuge behind a portable steel shield set at a safe distance, so that they may quickly return to work when the danger is past. Large boulders of ore are block-holed, or bulldozed by placing dynamite on the surface of the rock and covering the charge with mud.

There are 14 large shovels in operation, and a dozen or more blast-hole machines are in use constantly, drilling in ore, and in the barren rock that in places covers the orebody. An average of 8500 tons of ore is sent daily to the mill at Hurley, 14 miles distant, where it is crushed and concentrated, the concentrate going to the smelter at El Paso. The cost of producing copper at Chino is about 8.5 cents per pound. The ore is low-grade—about 1.8% copper—but there is estimated to be not less than 90,000,000 tons, as determined by extensive diamond-drilling, and the property is one of the most profitable of the disseminated-copper mines in the country and one of the largest.

CONSOLIDATED MAIN REEF CO.'S MILL AND CYANIDE PLANT, ON THE WITWATERSRAND.

Thos. H. Leggett: A Consulting Engineer

An Interview. By T. A. Rickard

You are a New Englander, Mr. Leggett, are you not?

A New Yorker, born at Flushing, Long Island, in 1859.

Therefore, you naturally went to the Columbia School of Mines?

Yes, after going through the introductory and freshman years of the College of the City of New York, I graduated in the class of '79 at Columbia.

What part of your training do you consider has proved of the greatest benefit to you in your work as a mining engineer?

The mathematical course, under Professor Van Amringe, and the chemical course, under Dr. Chandler. It so happened that during my time the mining course was in process of re-organization under Professor Trowbridge, while Professors Hutton and Munroe were just starting as Adjunct-Professors. The summer-school of practical mining, which Professor Munroe inaugurated with the class of '78, was of immense benefit.

What was your first employment?

As rod-man at $2 per day in river and harbor survey-work under General Newton, famous for clearing the East River of Hell Gate reef by dynamite. It enabled me to get my first experience in coast-surveying and later to take charge of a surveying party.

Where was this?

Along the rivers and harbors round about New York City and its vicinity, Long Island, and New Jersey.

What was your first work in actual mining?

After the surveying in '79 and '80, I was assistant at an iron blast-furnace on the Hudson river, and there obtained my first experience in metallurgy, also in book-keeping, and I am inclined to think the latter did me quite as much good as the metallurgy. When the boom in iron collapsed I was given an engagement in Mexico, on the staff of the Batopilas mines, in the state of Chihuahua. These mines were controlled by Alexander R. Shepherd, more familiarly known as 'Boss Shepherd' on account of his political career at Washington, he being the first and last Governor of the District of Columbia. His methods of cleaning up the old town were drastic, but they were most effective, and on his re-visiting Washington in '86 the city showed public appreciation of what he had accomplished.

What route did you take to Chihuahua?

I went through Denver, about Christmas time in 1880, and meeting Theodore Schwartz I obtained through him the opportunity of seeing the gold mines of Georgetown and Black Hawk before proceeding to Mexico. I went by train as far as Mesilla, at that time the construction end of the Atchison railroad, and staged 40 miles into El Paso, which town was so crowded that I was thankful for a cot, four in a room, in a little adobe hotel—by courtesy. Then we went by stage to the city of Chihuahua, a six-day trip on account of the snow, thence on mule-back for another six days across the Sierra Madre to Batopilas.

In those days the Indians were still on the war-path?

Victorio and his Apaches were very active, and I remember we sat in the stage-coach with our rifles across our knees most of the way, not that they would have done us much good, but more for the moral effect. I remember the stage being stopped at 10 o'clock one night as we were approaching the end of the day's run, by a Mexican on horseback, who stated that a little way ahead and on the same high-road there had been found the dead body of a Mexican still warm; he wished us to carry the news into the town we were then approaching, and inform the proper authorities by telegram. It was an unpleasant evidence of the nearness of the Apaches.

The Batopilas is a silver district, is it not?

The ore is valuable for its native silver. At that time they were just starting a 15-stamp mill equipped with

Frue vanners, amalgamating pans, and settlers to treat the lower-grade ores that always accompanied the rich native masses though in variable quantity, and carrying pyrite, blende, and galena as accessory minerals. These 'sulphurets,' as they were then called, contained much of the silver of the low-grade ore. The milling process was fully described by John C. F. Randolph, who originally reported on the Batopilas properties, in Vol. X of the Transactions of the American Institute of Mining Engineers. It was upon Randolph's advice that Shepherd and his friends bought these Batopilas mines from a Mr. Robinson, who had worked them Mexican fashion on a small scale for years, and who was then about 70 years of age. It is interesting to note that Robinson moved to Chihuahua and there became interested in opening up the old Santa Eulalia silver-lead mines, which have since become so productive.

How was the silver extracted?

The native silver was extracted by pan-amalgamation, and the concentrate was treated by the hyposulphite leaching process, after roasting. That was the process in vogue all over the West at that time for base silver ores. Walter Brodie was the mining engineer in charge, and he is still consulting engineer for the property, with headquarters in New York.

How long were you there?

Three years, until 1884.

You had a useful experience there?

It was particularly useful as it was my first actual mining experience, and being given charge of subsidiary properties, sometimes at a distance from headquarters, it gave a sense of responsibility and taught one to rely upon his own resources.

Why did you leave?

In order to get wider experience, as the mining at Batopilas was limited entirely to native silver ore of erratic occurrence and requiring but simple treatment.

What was your next appointment?

Chemist to a silver-lead smelter at Lake Valley, New Mexico, but as this plant remained in operation only a few months, I soon returned to New York and took an engagement as mining engineer with the New York & Honduras Rosario Mining Co., in Honduras, where I remained from 1884 to 1887.

This mine is still in operation, is it not?

Yes, and only last year I received a card from the directors commemorating the company's 35th anniversary and its 197th dividend.

This was an interesting enterprise?

Very much so. It was then in the early stages of development; in fact, it was producing only 10 to 12 tons per day when I went there, and inside of two years the output was increased to 100 tons per day of gold-silver ore, an oxidized quartzose ore with occasional cerrusite, pyromorphite, and some blende and galena. On the deeper levels the lode passed out of eruptive rock into the sedimentaries and this was accompanied by a change to sulphides, and a lower-grade of ore. The development of later years has discovered and opened up a whole series of profitable veins.

What was your metallurgy?

The ore was crushed by stamps and then amalgamated in pans—the original 'Comstock' pan. These, of course, have been superseded now, and most successfully, by the cyanide process.

What was the chief feature of your work at the Rosario mine?

Changing the method of working the mine from a gopher-hole of the Mexican *patio y patilla* type to the systematic operations of scientific mining and the transportation of the ore by means of a steep gravity plane and 1¼ miles of Halliday tramway, instead of by mules.

Did the climate affect you unpleasantly?

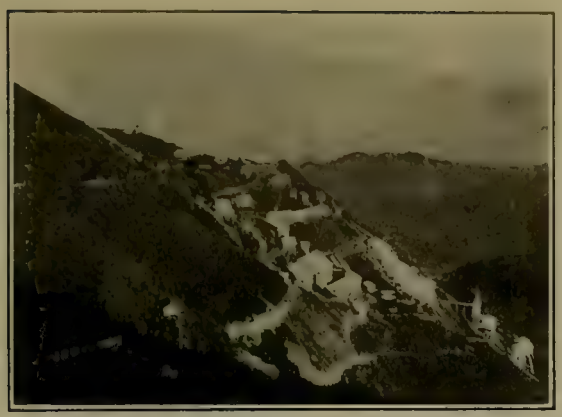
The climate was, unfortunately, malarial; the altitude at the mill was 3600 ft. above sea-level and the mine nearly 2000 ft. higher, but the foreigners suffered from malaria, and I among them. Indeed, I still have occasional unhappy reminders of my sojourn in Honduras.

So you were not sorry to have a change?

On my return to New York, I found that my friend Walter McDermott had become interested in a mine in Colorado, which experience he has dwelt upon at some length in his paper on 'Salting of Mines,' read at one of the meetings of the Institution of Mining and Metallurgy in London. The ore was supposed to carry native silver in highly payable quantity, but his samples had been salted after his examination, although so careful was he of these samples and so well did he guard them, that it was only through the subornation of an employee of the express company that they were able to get at them. He and his friends had brought suit against the vendors of the mine and he wanted someone to run the 10-stamp mill he had erected on the property, to give definite proof by actual milling operations that the ore was too low-grade to pay; so I operated the mine and mill some six to eight weeks, obtaining sufficient data to fully sustain his contention.

And then?

Soon after I was offered the management of the Darien Gold Mining Company, an Anglo-French concern with headquarters in Manchester, and in the fall of 1888, I left New York to take charge of operations at the mine, which was situated on the Darien peninsula about 150 miles south-east of Panama and about 100 miles inland on a plateau about 2000 ft. above sea-level. A description of the property was published in Vol. XXIX, Trans. A. I. M. E., by a later manager, Ernest R. Woakes. My work was that of the pioneer, having first to build a sawmill driven by water-power, fell trees, and saw out the lumber with which to build a 10-stamp mill, meanwhile of course developing the mines and installing the water-power plant to run the mill. The surface-work of the Spaniards had taken the form largely of sluicing the decomposed outcrop, or *manta*, and the detritus on the hill-



THE NEW ROSARIO MILL AND CYANIDE ANNEX CLOSE TO THE MINE.

sides, which latter were contoured with the ruins of numberless ditches. Our work was to sink shafts and open up the deposit systematically. The climate was so bad for me that I was unable to remain there long enough to fully develop all the properties. I was succeeded by William H. Radford, and he in turn was followed by Mr. Woakes, who opened up the Espiritu Santo, or south mine, with good results.

You must have been glad to get away.

Yes, the climate was extremely trying, on account of the excessive rainfall in the wet season. By the way, while in charge of this property, I had occasion to go to England to meet the directors, among whom were Lord Charles Beresford and Mr. Hammersley Heenan of Manchester, who was then working very hard to get a bill through Parliament for the construction of the Channel Tunnel between England and France. Jacob Higson was another well-known Manchester man on the board of directors. After a rest of six months at home I took the management of the Standard Consolidated mine at Bodie, California, subsequently becoming president of the company.

This time you got a high altitude?

About 8000 ft. above sea-level; with a climate described as "nine months winter and three months late in the fall."

What were the chief features of your work at Bodie?

The work there was extremely interesting. The credit for the resuscitation of the old Standard mine is due to Arthur Macy, a graduate of the Columbia School of Mines well known for his record at the famous Silver King mine in Arizona and elsewhere. He first examined the mine in 1890 and on his return to New York, was asked to take charge of the property, which he would not do until the company consented to give him $50,000 working capital, as the property had been allowed to run down. Macy expended this money chiefly in underground development and had just got the mine into workable shape when he died, so that the most I did was to continue his work. The mine was a system of what an old-fashioned miner would call 'gash-veins,' a network of quartz veins of which many showed no outcrop, while not one in fifty went below the 500-ft. level, but which often were wide, and sometimes rich, at about the 300-ft. level.

OLD ROSARIO MILL AND HACIENDA AT SAN JUANCITO, 1¼ MILES FROM THE MINE.

Is that the water-level?

No, the water-level was about 800 ft. down the main shaft, which was sunk to 1200 ft., but has not been unwatered for 25 years or more.

How far did oxidation extend?

Down to the lowest level open to inspection, that is, the 750-ft. There were not many veins at this level, indeed, very few of them continued below 500 ft. About four years ago I was asked to go to Bodie, to look into the question of unwatering and re-opening the mines in depth, but I was forced to advise against doing so.

You must have made at Bodie one of the early applications of the cyanide process in California.

Yes, and I found the work extremely interesting. The gulch was full of old tailing, assaying $5 to $6 in gold, so one of the first things done was to send a large sample (a ton or two) to the Cyanide Extraction Co. at Denver, the American representatives of the MacArthur-Forrest people of Glasgow.

What year was that?

In 1892. These people advised that the extraction was poor, so the matter of treating the tailing lay dormant for quite a year, until on a trip to San Francisco I met Alexis Janin, who told me of some successful laboratory work he was doing in cyanidation with the assistance of Charles W. Merrill, then recently graduated from the University of California. I immediately sent them some samples of our tailing, and they reported a most hopeful extraction, between 80 and 90%, whereupon I requested Mr. Merrill to come to Bodie, as I felt the necessity of testing upon a larger scale. We used two small tanks, with a capacity of half a ton each, and a small zinc-box about 6 inches square by 8 or 10 ft. long, and we ran 16 charges or 8 tons in all taken from all parts of the tailing-pond, obtaining therefrom a bar of bullion weighing nearly 7 oz., quite large enough to determine definitely whether the laboratory tests would be sustained in practice. The results were so good that we erected the first 100-ton capacity cyanide plant on the Pacific Coast, work being started in June 1894, the plant completed in September, and paid for out of the proceeds by early December, when it was forced to close-down, on account of the severity of the weather. An interesting feature of the little plant was that the tanks were discharged by hydraulicking, using mine-water from a reservoir a few yards up the hill, the discharge-sluice under the tanks being placed at about 4% grade.

Do you recall any other interesting feature?

Electric transmission of power. We were under the unfortunate necessity of using wood for fuel at both mine and mill, at a price of $10 per cord. This made very large fuel-bills, and in casting about for a remedy, I found that Mr. Nunn, at Telluride, Colorado, had, in 1892-'93, put in a power transmission about three miles long using the Westinghouse single-phase synchronous system to operate a small mill. Finding water-power 13 miles distant from Bodie, we concluded that if power could be carried three miles it would be fairly safe to try it for 13. On consulting the General Electric Co.'s representatives at San Francisco, I found that the development of power-transmission by electricity was in such an early stage they were still wedded to the direct current, and little as I knew about electricity, I felt the uncertainty of the methods they proposed. I then consulted W. F. C. Hasson, electrical engineer, graduate of Annapolis, who had just opened an office in San Francisco—in fact, I had the honor of being his first client. This resulted in tying up with the Westinghouse company, which took the contract to carry the power for that distance—13 miles—using a 250-kw. generator at the water-power end, direct-connected with Pelton water-wheels under 300-ft. head, without transformers, the current being generated at 3000 volts and carried on No. 1 bare copper wire to Bodie, where it was applied to the operation of the mill. The plant was in operation in the summer of 1894, but was not accepted until late in that year, on account of difficulties in protecting both the generator and the motor, more particularly the latter, from lightning and from static electricity, with which the air at that altitude was often highly charged. The first lightning-arrestor was of the Wurz spool type, then just introduced, but it had to be supplemented with other arrestors, and as the company was obliged to give us a 30-days continuous run before acceptance of the plant, I remember it was some months before this was accomplished, although we were really in successful operation of the mill by electric power and the steam-engine and boilers had been disconnected most all of the summer of 1894.

Have you any further metallurgical reminiscence?

Another interesting experience was in connection with the treatment of the concentrate from the 20-stamp mill, which I found equipped with Frue vanners and the Boss continuous pan process, which latter proved ineffective. For the treatment of this concentrate, a drying-furnace had been built of the reverberatory type, and a magnetic separator installed with the object, as was said, of taking out the excess of iron oxide. These, however, had not been used much and there was therefore a large accumulation of concentrate, which had not been shipped on account of the heavy freight and smelter charges, Bodie being 40 miles from the railroad. We tried at once to treat this concentrate, using ton-charges in one of the Comstock pans, with a very heavy addition of salt and sulphate of copper, knowing that a base bullion would result, but there was nothing in the concentrate itself to interfere with the well-known reactions of the *patio* process. The result was most satisfactory, giving quite 85% extraction on a concentrate running from $120 to $160 per ton, so that we had a handsome clean-up and the tailing, of course, was all saved and subsequently treated by cyanidation.

How long were you at Bodie?

Four years. I went from there to Johannesburg, South Africa, by way of London, having been retained by the firm of S. Neumann & Co., as their consulting engineer. This was in 1895.

This firm controls several mines on the Rand, I believe?

At that time, while they had large interests, they had not the control and operation of many mines, but this situation changed in a short time, so that they became

THE STANDARD CONSOLIDATED POWER-HOUSE, IN 1894, THE FIRST LONG-DISTANCE ELECTRIC-TRANSMISSION POWER-PLANT IN THE UNITED STATES.

responsible for the operation of such properties as the Consolidated Main Reef, Wolhuter, Witwatersrand Deep, Knight Central, Vogelstruis Deep, Treasury, Cloverfield Deep, and others.

What seems to you now to have been the striking feature of work on the Rand, as you saw it?

Perhaps the most striking feature was the courageous development of the deep-level area, resulting from merited confidence in the persistence of the ore, and the bold manner in which millions were expended on single properties in the systematic effort to reach and open up this deep ground.

You liked the mining laws of the Transvaal?

Yes, indeed; a striking feature of the mining was the absence of litigation. The Witwatersrand mining area comprises a stretch of country now about 50 miles long by 2 to 3 miles wide, covered from end to end with mining claims grouped into mining companies in active operation and often controlled by men of different nationalities, yet a mining law-suit is a practically unheard of thing, while those that have occurred during the past 20 years can be counted on the fingers of one hand. This is eloquent testimony to the practical efficiency of a mining law that limits the four sides of a mining claim by vertical planes.

Were you interested in the geologic study of the Rand?

The geological work on the Rand was highly interesting, and we were visited by many eminent and distinguished geologists, among whom were Agassiz, de Launay, the French authority, and Becker of the U. S. Geological Survey. Dr. Becker was one of the first of these geologists to visit the goldfield, coming there early in 1896, and he did some really remarkable work, with which I had the privilege of keeping in close touch, as he

THE CONSOLIDATED MAIN REEF MINE

was engaged by my firm. One of his chief investigations was a search for the westward continuation of the main Reef series, on which he spent several months with the result of establishing the existence of an extensive fault, beyond which that lode series was lost. He constructed a model to illustrate the existing condition and so far as I am aware his findings have never been disputed, nor the continuation of the Main Reef series found.

Another happy feature of our work there was the lack of secrecy; the readiness with which the underground workings, the surface equipment, the assay-plans, and the milling results were thrown open to the inspection of visiting engineers—the good fellowship that obtained among them and the entire lack of professional jealousy. Many problems had to be solved in those days—mining, mechanical, and metallurgical—and the exchange of ideas among the engineers and metallurgists that had to attack them was cordial and unrestricted.

What did you think of British company methods?

The English methods of company administration, with their reports conspicuous for their thoroughness and their close attention to detail, were something of a lesson to the American mining engineer. The American, always keen for results, was in those days given perhaps to taking too many short-cuts with a possible slurring of apparently unimportant administrative details. The influence of the thorough and methodical methods of the English administration was most salutary. The explicitness of the reports of the Johannesburg mining companies is a case in point. Take for illustration a report just received from one of my old companies for the quarter ending July 31, 1916. Although it has been operating for over 20 years it starts with a statement of its capital thus:

"Capital - - - - - - - £860,000

"In 860,000 fully paid-up shares of £1 each. (Fully issued.)"

Then "Directorate and names of directors and alternates.

"Head Office - - Cullinan Building, Johannesburg

"London Office - - Salisbury House, London Wall"

Then follows, "Expenditure and Revenue statement" (for the quarter).

"Calculated on the basis of the tonnage milled."

"120 stamps, 4 tube-mills, and cyanide works.

"Milled, 107,000 tons."

Detailed "Working Expenditures and Revenue" given in two columns, one of totals and one of "per ton milled," and final totals of yield, cost, and profit for the three months as follows:

		Per ton
Cost	£95,161	17s.9.45d.
Profit for quarter	40,774	7s.7.45d.
Yield	£135,935	25s.4.90d.

Then follow details regarding the operations for the quarter in mine and mill, with statement of ore-reserves, their estimated value, etc.

Could anything be clearer or more satisfactory to the stockholder? Most if not all of even our best-managed mining companies producing gold, copper, or other metal—companies the excellence of whose management is beyond criticism—while giving in their quarterly reports to stockholders a comprehensive statement of the three months operations with yields, costs, and profits in detail, make no mention of such important matters as the place of incorporation of the company, amount of its capital, number of shares issued, location of offices, etc., while even in their annual reports one has usually to refer to the accountant's statement to get information stated on the front page of every English report, quarterly or annual.

These important details regarding a company are always of value, but especially so to a stockholder living away from the big centres or in some remote part of the country, and no doubt their incorporation into the reports of our mining companies will soon be adopted in view of the great progress already made in this direction. As regards the unnecessary amount of red-tape with which the English administration of mining companies is often credited, it is only fair to say that the Johannesburg companies were in turn benefited in this respect by their contact with American methods.

Do you, or do you not, believe that the Main Reef series has become impoverished in depth?

It is now ten years since I have been on the Rand, and I have naturally fallen out of touch with the development of the deeper workings, as also with the local economic conditions that are almost as vital as the grade of the ore, but I have obtained the impression that there is a falling off in the grade of the ore, taking the Rand as a whole. There have been notable exceptions to this, more especially on the eastern flank where, in some mines, such as the Brakpan, high values obtain and still exist in large areas and over considerable reef-widths, as much as 4 and 5 ft., but my impression is that these rich areas are more scattered, and that therefore, taking the deep ground as a whole, its gold content will average less per ton than that of a corresponding area closer to the outcrop. This is in accordance with the general experience in gold mining the world over.

Did you have any unpleasant experience at the time of the Jameson Raid or the beginning of the war?

Nothing particularly unpleasant. These days were often exciting and always interesting. Many of the American mining engineers kept out of the Raid and all but one or two out of the war. Our families went to the Coast—to Durban or to Capetown—three or four times on various war scares, and of course the final exodus just before the war was disagreeable on account of the crowded condition of the trains. On the whole, it was remarkable how slightly the operation of the mines was interfered with, up to the actual outbreak of hostilities.

By the way, when were you married?

I was married in March, 1891, to Miss Fanny Marshall Borrowe, and we have three sons, the eldest about to be graduated with degree of M. D. from the College of Physicians and Surgeons in New York.

Do you consider that the Rand offers a good training in mining?

It undoubtedly does. It affords excellent training in

modern methods of underground work, and of large-scale operations in deep hoisting, pumping, ventilation, etc., at the same time instructing in details with characteristic English thoroughness. Also for learning the particular phase of metallurgy in use there—stamp-milling and cyaniding of quartzose gold-ores—I know of no better field, but, in order to widen the young engineer's experience and knowledge, work there should be followed by work in different types of deposits in other parts of the world.

How does the Kaffir labor compare with the Mexican?

Very favorably. The Kaffir, after a month or two of breaking-in, becomes a fairly good worker. But in order to obtain the best efficiency it is necessary to employ the task system, under supervision, of which the Kaffir requires but little more than the Mexican. Like the Mexican, he is docile, and as he is given no chance to drink while in the compounds, he is always ready for work on Monday morning, whereas the Mexican has his too frequent *fiestas*.

How about the white labor on the Rand?

In my time the white laborer was highly paid, sometimes to excess, considering the amount of work done. It was necessary, in order to be sure of a full day's work, to put him on contract. This was at a high figure, partly on account of the great demand, so that a good miner would often make as high as $300 to $400 per month. All this has been remedied in the past ten years, so I am given to understand.

How long were you in South Africa, Mr. Leggett.

Eight years.

Did you go to Rhodesia?

Yes, I made one trip to Rhodesia, and saw there some of the principal mines, the Globe and Phoenix, Giant, Selukwe, and others, but I left with the impression that the country was plastered six feet deep with mining shares. The Blue Book, issued at that time by the Chartered Company, showed, if I remember rightly, some 250 to 260 companies with capitalizations ranging from £50,000 into the millions, and you could count on the fingers of one hand the number of producing paying mines. Doubtless by now this too has been largely remedied.

What was your next move?

In the autumn of 1903 I returned to London, where I opened an office in Salisbury House for independent mining engineering work, retaining connection with the firm of S. Neumann & Co. I lived at Chislehurst, with

COMMISSIONER STREET, JOHANNESBURG.

headquarters in London, until 1907, making several trips to the United States in that time, and a couple to Russia and Siberia, including the examination of the Spassky copper mine, which was then in the early stage of its development.

Another interesting examination was that of the Sudbury nickel-copper district in Ontario, with special reference to the Victoria mines of Dr. Ludwig Mond, whose properties were at that time—1901—largely undeveloped, though fairly extensive diamond-drilling had been done. I remember suggesting to Dr. Mond, whose private car was on a side-track at the mine during the examination, that he approach the Canadian Copper Company with a view to buying them out, thereby making a business of sufficient size to be worth his while and at the same time securing going properties. That company was then diamond-drilling its extensive Creighton deposit. Dr. Mond went to Cleveland, Ohio, the headquarters of the Canadian Copper Company, but returned

shortly saying they asked the unwarranted sum of $6,000,000 and that anyway they would have to come to him sooner or later, as he controlled the only true process of separating nickel and copper. Dr. Mond, in addition to his other famous work in the field of chemistry, discovered and finally put into successful operation a process for making this separation, hence his desire to secure nickel mines and his participation in mining. All the matte from the Victoria mine, after being brought up to about 40% each of copper and nickel, was sent to his works at Clydach, in Wales, for final treatment and separation. But in this case the chemist got the better of the business man, for inside of eighteen months Schwab bought these properties, which are now consoliated into the International Nickel Corporation. The Mond company, however, is also in successful operation at Sudbury.

Have you any opinion as to the prospects for American enterprise in Siberia?

I think it has been largely forestalled by the activity and initiative of the English mining houses, which have had their representatives there for the past ten years. It is true that some of these representatives have been American engineers, but they have mostly been connected with and working for London houses. I think, too, that this is too far afield for American capital, just as South Africa has always been considered to be too distant, quite aside from the fact that in the latter country all the opportunities were already pre-empted.

Then you realize, or you believe, that the American capitalist has not yet learned to use his money far from home?

I would hardly go so far as to make such a statement, in view of the amount of American capital that has been invested in mining on this continent, stretching from Alaska in the north to Chile in the south; I would rather say that American capital in the mining field certainly has been largely restricted to this continent, and apparently with good reason, considering the undeveloped areas that have existed and still exist.

When did you leave London?

In 1907, when I moved to New York, and opened an office in Broad Street, being joined there in 1908 by my friend and former assistant in South Africa, Fred Hellmann. We remained in partnership until the spring of 1912, when I became consulting engineer for the American Smelting & Refining Company and a little later Mr. Hellmann took charge of the Chuquicamata mine for the Chile Copper Company.

Reviewing your career, what piece of advice would you most like to give to the younger men?

I think one of the most important things for the young mining engineer to bear in mind, one of the best lines of action he can adopt is to disregard the amount of pay received during the first years after graduation and devote himself to acquiring a wide experience covering as many different types of ore deposits and methods of mining and metallurgy as possible. While thus broadening his experience he will also be enabled to make a wiser decision as to the line of work along which he prefers to specialize. I am also a believer in a young engineer spending a goodly number of years in the actual operation and management of properties, for nothing can replace the executive experience and knowledge of men so gained. If he follows this course the matter of emolument will soon regulate itself to his satisfaction.

Are any of your sons to become mining engineers?

My eldest son receives his degree of M.D. next month. My second son, now Second Captain of the Battalion and in his last year at the Virginia Military Institute, is thinking strongly of electrical engineerng as his life work, while my youngest son is only 14, and we don't know yet what he will be, but there is always a possibility of his wanting to become a mining engineer.

Do you consider that smelter settlements should be based on the price of metals, as quoted in a trade paper? Do you think it advisable and practicable to take the prices at which the smelting company actually sells the metal, and use that as a basis of settlement, making a temporary adjustment until that price is ascertained?

I think it most advisable that settlements between smelteries and their customers should be based on the actual price obtained for the metal sold by the former and not upon a trade-paper quotation, but I question whether it is practicable to do this. "It is a condition and not a theory that confronts us," and as the metals are sold chiefly by agents or selling companies acting on behalf of the smelteries I doubt very much whether it would be possible to get them to disclose in each instance the actual price obtained, especially since they frequently have to carry over the metals for some very appreciable length of time.

NEW APPLICATION OF CYANAMID TO PHOSPHATE ROCK. Extensive and completely equipped phosphate properties in the pebble-rock district of Florida have been purchased by the American Cyanamid Co. of New York, comprising the mines of the Amalgamated Phosphate Co. at Brewster, Polk county, in the centre of the pebble district, and the output will be used for manufacturing a new fertilizer, containing ammonia and phosphoric acid, which the American corporation will manufacture in the plant it has recently completed on New York harbor. The phosphoric acid will be derived from the Florida phosphate rock and the ammonia content from the cyanamid which the company manufactures at Niagara Falls, Ontario. The entire present output of the phosphate mines having already been sold for a period of years, the American Cyanamid Co. is installing equipment to double the output. The mine will be operating at its enlarged capacity by the end of this year. Increasing demands for cyanamid products will cause the American corporation to increase its holdings and add to the activities of rock-phosphate mining. The mining of phosphate rock in the United States began in South Carolina in 1867.

The Miami Appeal—III

We quote further from the Minerals Separation oral argument. Mr. Kenyon is insisting before the Court that 835,120 is a pioneer invention.

Now, the essential things in our process are the air bubbles in a modified pulp and collision of those air bubbles with the metal particles, and all else follows from that.

Just those three things: Air bubbles, a modified pulp, and sufficient movement to bring about the collision of those air bubbles and the metal particles. Whence or how the air bubbles come is a non-essential. They are not altered by the way in which they come. It is the same air. It has the same characteristic imparted to it by the modified water which appears when it comes out as a bubble. How the collision is brought about is a non-essential.

Another way of putting it: Whether you aerate by agitating—I would very much like your Honor's attention. I am coming to that afterward, if you will excuse me, as my time is so short. Now, whether you aerate by agitating, as here (indicating the Gabbett cone mixer) or agitate by aerating, as here (indicating the defendant's Callow cell)—whether you aerate by agitating as in our first example in our first patent in suit, or agitate by aerating as in the second example of our patent, you have in both cases these five things: (1) Critical proportions of oil present; (2) the peculiar air bubbles incident thereto; (3) the contact of these bubbles with the metal particles; (4) flotation by reason of that contact; and (5) froth-formation above the pulp carrying those metal particles.

And the peculiar air bubble function in essentially the same way as described in the patent in suit (page 1, lines 89-96). They take hold upon the metal particles with which they collide, and never thereafter let them go.

THE COURT (Buffington, C. J.): And so permanent in the defendant's machine—

MR. KENYON: Yes.

THE COURT (Buffington, C. J.): That they last for twenty-four hours. I say, in the defendant's machine.

MR. KENYON: Yes.

THE COURT (Buffington, C. J.): That they last for twenty-four hours. That is what the Supreme Court said.

MR. KENYON: Won't you just let your mind remain open on that?

THE COURT (Buffington, C. J.): I am only calling your attention to the fact that in connection with that argument I was following here what the Supreme Court had said.

MR. KENYON: I am going to apply my argument to what the Supreme Court says.

The air bubbles function in essentially the same way, however you get them in—that is determined by the modifying agent in the water—and the two means or ways of getting them in and of bringing about the collisions are mechanical equivalents for one another in the prior art, and well known mechanical equivalents, as I have shown, and they produce the same concentration of ore result, and through and by means of substantially the same froth carrier, a froth carrier that has the two characteristics that the Supreme Court emphasizes, namely, (1) minuteness of oil, and (2) large percentage of the ore metal, and that is persistent and coherent enough to do the work that it is called upon to do by the process.

THE COURT (Buffington, C. J.): Mr. Kenyon, where do you get the air bubbles in this beater process of yours? Where do you get them?

MR. KENYON: Well, your Honor's mind has to be disabused of that notion that there is any beater in our process. Our patent does not show a beater.

THE COURT (Buffington, C. J.): Well, you certainly describe a beater.

MR. KENYON: Not in our first patent. We did that in our second patent.

THE COURT (Buffington, C. J.): The Supreme Court thought you had a beater, didn't it?

MR. KENYON: Now, you force me to come to that.

THE COURT (Buffington, C. J.): No; I do not force you to anything.

MR. KENYON: I am only going to ask you to underline two phrases in this opinion of the Supreme Court that may have escaped your attention.

On page 3 of this little pamphlet, the second paragraph, please underline these words:

"The process of the patent in suit *as described and practised.*"

Now, everything that follows that is simply practice, description and practice.

Now, in contrast to that, will you turn to the last page of this opinion? I hope it will be illuminative. The last page, third line:

"And the patent *must be confined.*"

Now, there is the only construction of the patent as a monopoly in that whole opinion. "And the patent must be confined." All that preceded it, every word that was said before it was a description of something as practised, as described either by witnesses who were talking about practice, or their actual practice.

Now, I am going to come to that.

So that there is nothing of limitation in that opinion until you come to the last paragraph. There is only description until you come to that last paragraph. And, if your Honors please, in my judgment, for what it may be worth, no nine judges will be more astounded if your Honors should go on record as finding in this decision of

theirs a limitation of this invention to any particular kind of agitation or any particular kind of froth.

Now, may I take up the thread of my argument—

THE COURT (Buffington, C. J.): If that is the case, we have the assurance that if we go wrong we will be instantly corrected.

MR. KENYON: We shall make every effort in the Supreme Court. We have to, of course, because this invention is the most important invention—this group of inventions are the most important inventions—

THE COURT (Buffington, C. J.): Mr. Kenyon, that is why I wanted to get your views on it, and I ask you a plain question. You certainly show a practice.

MR. KENYON: Yes.

THE COURT (Buffington, C. J.): Do you agree with me?

MR. KENYON: We show a practice, surely. But our patent is not necessarily—

THE COURT (Buffington, C. J.): And that practice consisted of what has been called here "beating in air."

MR. KENYON: No. Well, I will come to that.

THE COURT (Buffington, C. J.): Then you didn't show it?

MR. KENYON: We did say that in our second patent, and in our practice about the year 1908, and that is what the Supreme Court was talking about. It was the particular froth, gotten in that practice, applied to a particular ore (that had 45% of metal in it) that all those witnesses were talking about—that the Supreme Court quoted.

Now, just think of that a moment. Forty-five per cent of metal. Pretty nearly every other particle a metal particle. Contrast that with the defendant's ore. One per cent of metal. One particle of metal in every hundred. Ninety-nine collisions are with gangue particles. You must have with the defendant's lean ore a super-abundance of air. At least, one can well appreciate why there should be myriads of air bubbles searching everywhere, through every nook and corner of that ore pulp, so that not a single one of those few and far between metal particles shall escape. And, now, in the other case, when you get a froth in which every bubble carries fifty metal particles (because they will keep on attaching themselves to a bubble until it is absolutely armored) those armored bubbles, even after the water film of the bubbles had dried away, would stand up there as skeleton bubbles. That phenomenon we have seen. Simply because of the richness in metal, and that richness simply because the concentration was of an ore rich in metal.

Now, along that line is the explanation of all this confusion about the early practice of this process.

THE COURT (Buffington, C. J.): I do not seem to be able to get the thing to you, that this is an honest groping in my mind for what I am unsatisfied about.

MR. KENYON: Yes.

THE COURT (Buffington, C. J.): I take it that you cannot have a bubble unless you have got some air inside of it. Am I right?

MR. KENYON: You are right. You cannot have a bubble below the surface without getting in air below the surface.

THE COURT (Buffington, C. J.): Above or below the surface, you cannot have a bubble anywhere, unless you get some air in.

MR. KENYON: Yes. Even with the froth you cannot get a bubble without having some air inside of it.

THE COURT (Buffington, C. J.): Now, you get bubbles. You disclose a way of getting bubbles.

MR. KENYON: No.

THE COURT (Buffington, C. J.): You do not? Then, I am through. Our minds are so far apart that I don't know. Because when the House of Lords, or whoever it was over in England, spoke there of forming a multitude of air-cells, I thought there were air-cells in this thing. But you tell me not.

MR. KENYON: In the pulp? Yes; there are air-cells. I have misunderstood you. What I meant to say was that we did not invent some particular way of getting that air in there.

THE COURT (Buffington, C. J.): I don't care whether you invented it or not. You have said, haven't you—

MR. KENYON: Yes, that is what we invented, getting cells there any way you please, and then movement any way you please.

THE COURT (Buffington, C. J.): Do we start with the proposition that there is air in cells?

MR. KENYON: I don't think you can have a cell without air.

THE COURT (Buffington, C. J.): Do we start with that proposition?

MR. KENYON: I am willing to start there, yes.

THE COURT (Buffington, C. J.): I am not taking a hypothetical case, I am endeavoring to get down to the facts.

MR. KENYON: Yes.

THE COURT (Buffington, C. J.): Do we start with that?

MR. KENYON: Yes.

THE COURT (Buffington, C. J.): If we do not, why say so, and I will know where we are.

MR. KENYON: I do not know where you mean to start. You mean before we start the machine going?

MR. GARRISON: He means you cannot have a cell without air.

THE COURT (Buffington, C. J.): I will not take up your time.

MR. KENYON: You cannot have a cell without air. Can I help you along that line?

THE COURT (Buffington, C. J.): I am afraid I am taking your time.

THE COURT (Woolley, C. J.): If I understand your reference to what the Supreme Court said on page 8, when you asked us to underline the words "the patent must be confined"—that is, must be limited?

MR. KENYON: Yes.

THE COURT (Woolley, C. J.): "To the results ob-

tained by the use of oil within the proportions"—which is one per cent—"often described in the testimony."

MR. KENYON: That is the only limitation.

THE COURT (Woolley, C. J.): Then that means precisely what Claim 12 that was cancelled means, does it not?

MR. KENYON: Oh, no.

THE COURT (Woolley, C. J.): Then clear me up on that. As I read that limitation, if that limitation means, or rather if that language means, that you are confined to the 1%, and confined by nothing else, limited by nothing else, then I think that means the same as your withdrawn Claim 12.

MR. KENYON: The Court was speaking of our claims which were before it and which are here. Those claims specify agitation and froth. When you get those three things together, that minute quantity of oil and agitation and froth, you have—

THE COURT (Woolley, C. J.): That is what the Supreme Court says on another page. You are tying us down to this one sentence on page 8.

MR. KENYON: Only on the matter of construction. They only construe the patent there. They explain the process everywhere up to that point. There they lay down a limitation of the patent and that is the only limitation they lay down.

THE COURT (Woolley, C. J.): Then we are not confined to the use of oil, but we may consider the question of agitation and the result of the oil and agitation in the nature of froth, is that the idea?

MR. KENYON: Yes. It is perfectly open to this Court, in my judgment, to interpret agitation any way it pleases, to interpret froth any way it pleases. I do not think the Supreme Court has passed upon what the limitation of this patent and of this invention as to the agitation is or what the limitation of this patent as to froth is. It has simply passed upon what the limitation of this patent as to the quantity of oil is.

As to froth, the patent in suit contains no requirement—you may read it from end to end—other than that it do the work of carrying the metal up out of the liquid and over. Whether it be more or less aerated is a matter of degree, not a difference of kind. We made our froth here before you and put an excess of air into it. And can you say that the froth was thereby changed in kind? It had the same minimum proportion of oil. It had the same large percentage of metal. It was still capable of carrying the metal and going over a lip, and therefore acting as a separator and conveyor for that metal. All the essentials were there that were required by a froth in this art.

In both cases, aeration by agitation and agitation by aeration, there are present these two things; there is present aeration and there is present agitation, and the co-operation of the bubbles and the metal particles proceeds by that same selective action of the bubbles upon the metal particles as against the gangue that is described in the patent in suit, and I just want to read three or four lines from Judge Bradford on that same subject at the bottom of page 46 of his opinion, where he said, as to these two froths and processes:

"In order that the bubbles in the pulp mixture may come in contact with the metallic particles, there must be such movement between them as cannot be wholly accounted for by selectivity as between them * * *. That is to say, they won't jump together as though electrified. They must be moved together.

" * * * and their movement so far as not accounted for by selectivity is the result of agitation; and whether such agitation results from the stirring or beating of the mixture or the forcing or admission of air into it is immaterial; for what this court is dealing with is not an apparatus patent, but a process patent."

In the first patent in suit there is no limitation as to specific apparatus. Just before the claims occurs the statement:

"The nature and arrangement of the apparatus used may be varied without departing from this invention."

Substitute another way known in the art for aerating and agitating, and you have the defendant's operation.

How can the agitation of this first patent in suit be limited to mechanical agitation, when it has two illustrations of what it means, and one of them is not mechanical agitation? That flies in the face of every principle of construction of a patent, and demonstrates that the Supreme Court was not construing this patent in the matter of agitation, for it took no note of that fact.

THE MACHINE-DRILL first was introduced in 1838 by J. M. and John N. Singer, and was actuated by means of a cam that raised the drill, which on being released, fell by gravity on the rock. Drills of this type were called 'drop-drills.' They could only be used in boring vertical holes. Several of these machines were employed in canal work in Illinois, but were cast aside after about two years, not being satisfactory. The first steam-drill was constructed by J. J. Couch and Joseph W. Fowle in 1848. In this machine the drill-bar passed through the piston of the engine, and was alternately drawn back and thrown against the rock. It was used but a short time. Mr. Fowle then experimented with a drill in which the bit was solidly secured to the piston-rod, and although he made five different machines, he was unable to attain the success he expected and gave it up. In 1861 M. Sommeiller invented a piston-drill similar in principle to that of Fowle, but of different construction. To this machine he successfully applied compressed air—the first to use this means of operation. Messrs. Brooks, Burleigh, and Gates made a machine similar to that of Couch and Fowle; it was used in the Hoosac tunnel, though not a satisfactory drill. In 1866 Charles Burleigh bought the Fowle patent and made a new machine of the solid-piston type with few parts and strong enough to bear the shocks of the work. This was the first really successful machine-drill, and in some of the older mining districts machine-drills of any make are still called 'Burleighs.'

The machine-drill and nitro powder have made a vast difference in the economy of mining.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

PERCUSSION figures are the six-rayed stars produced in some minerals, notably the micas, when a crystal is struck or impressed by a blunt point.

PRIMERS for blasting should never be made in the same place that dynamite is stored, nor should the detonating caps and powder be kept in the same magazine.

BECAUSE dynamite occasionally burns without exploding, the fact should not lead to the conclusion that there is no danger when dynamite is burning; it sometimes explodes as well.

DENTAL GOLD is very porous, and when particles of it are hammered together they will adhere and form a solid mass, but there is no evidence that nuggets found in placers were ever formed in this way.

TIN has a peculiar property not possessed by any other mineral, known as the 'cry' of tin. This name is given to a peculiar crackling or squeaking noise emitted by a bar of tin when bent, or bitten by the teeth.

AT THE FALCON MINE, in Rhodesia, ore containing 2½% copper and $6 gold per ton is treated as follows: crushing by Nissen stamps; concentration on vanners; regrinding in tube-mills; flotation; sintering of the concentrate; and smelting in blast-furnaces.

AUTOMATIC ore-feeders in stamp-mills are considered by a few old-fashioned people to be no improvement on hand-feeding with a shovel. A man who can feed a stamp-battery as well with a shovel as it is done by an automatic feeder would be worth more doing something else.

A TEST for the presence of gypsum in water may be made by placing the water in a test-tube to the depth of two inches and adding a little barium chloride; if a white precipitate is formed that does not re-dissolve on the addition of a little nitric acid, calcium sulphate is present in the water.

CLEAVAGE in minerals is a property that permits a crystal to split along any plane having the direction of the cleavage. Mica is a mineral possessing this property in an eminent degree. Parting, in crystals, is different from cleavage, and can only take place on a plane that is the surface of twinning-lamellae.

BORAX is obtained chiefly from the mineral colemanite, a hydrous calcium borate, containing when pure, 50.9% boron trioxide. The ore is often mixed with aluminous and calcareous impurities, in consequence of which it is usually graded at the mines before shipment, the first grade running about 30% and the second 20%. The price is $1 per unit of boron trioxide contained. The present nominal quotation for crude borate mineral is $30 per ton. About 65,000 tons is produced annually in the United States, the most of which is from California.

CARBORUNDUM is an artificial compound containing 32% of carbon and 68% of silicon, and is a product of the electric-furnace. It is used as an abrasive, in the manufacture of grinding-wheels, and for sharpening-stones of many degrees of texture, from coarse to razor-hones.

ORE-POCKETS beneath a mine-level at a shaft are generally cut adjacent to the shaft, but in the case of a shaft having a low angle of inclination the pocket may be cut back some distance from the shaft, leaving a block of solid rock between, connection being made with the shaft below.

THE SAFETY DEPARTMENT of the Industrial Accident Commission in San Francisco has introduced safety nets for buildings under the course of construction. It has been found that the law calling for temporary flooring of buildings is impracticable. The distance to the floor is too far. The safety net supplies the need, for a man falling into a net is uninjured. The cost of the net is nominal; it is easily adjusted and can readily be transported from one place to another. It is similar in character to those employed by fire departments in the large cities to catch persons jumping from burning buildings.

FLOTATION has been tried on a gold-bearing arsenical pyrite ore from the Barberton mine in the Transvaal. Fine-grinding to 150-mesh and cyaniding gave only 45% recovery, roasting and cyaniding gave 82.5%, gravity-concentration and cyaniding gave 70%; flotation tests with various oils in neutral alkaline and acid circuits were made by F. Wartenweiler on the Rand in an agitation-type machine. The best results were obtained in a slightly alkaline solution, the ore being crushed to 90-mesh, and treated with wood creosote and paraffin oil. The middling and tailing were treated by direct cyanidation; the concentrate by roasting, amalgamation, and cyanide, giving 87.1%.

EAR-DEFENDERS, designed by artillery-men in Europe, are being tried in stamp-mills on the Rand to lessen the effect of the sound on the ear-drums of millmen. The apparatus consists of two small vulcanite plugs, shaped much like the pawns used in a game of chess, and fitting into the ears. A hole is made through the length of the pieces, and at the enlarged bell-mouth end a fine wire-screen is fixed. This screen breaks the waves of sound. At the Knights-Deep mill (120 stamps) it was considered that a broken stem or any unusual noise was more easily detected when wearing the defenders. Also, hearing becomes normal quickly after leaving the plant. The use of cotton-wool in the ears is not always safe, sometimes causing obstructions later on.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

PLATTEVILLE, WISCONSIN

LABOR FAMINE IN WISCONSIN ZINC FIELD RELIEVED.—HEAVY OUTPUT MAINTAINED.

Steady prices, regarded as satisfactory by leading operators in the zinc field of Wisconsin, were the main incentive toward an exceptionally good showing for February, a month not usually noted for standard records. The weather was uniformly good and roads were in fairly good condition for hauling, enabling the outlying producers to reach track with little difficulty. Labor stringency was much relieved by the influx of many foreigners attracted by the high scale of wages being paid to all classes now in demand, at the mines, and power service was uninterrupted following the completion of improvements and additions to the main service corporation at Galena, Illinois; representing increased investments to the amount of about $500,000; and now well equipped to carry any load the zinc mining industry may impose upon the Inter-State Light & Power Co. (H. M. Byllesby & Co.) To further enhance the facilities of rapid ore handling the State Railway Commission practically compelled the Chicago & Northwestern Railway Co. to provide a branch from the main line of the Galena division to the New Diggings district and preliminary surveys, the securing of the right-of-way, and the actual construction were begun to the extreme delight of nearly all the leading operators in this and the Benton district, and from which section is coming better than half of all the ore now being produced. Here, too, is found the greatest amount of actual development of new mines and the proving of large tracts of virgin territory upon which the margin of anticipation has broadened with the scope of the enterprises undertaken. Without undue pressure from outside sources the building of a short line must prove mutually beneficial to miner as well as carrier.

Standard 60% zinc ore opened the month of February at $75 per ton base and some premium grades called for figures nearer to $80 per ton. Refining plants discontinued shipments for a time, expecting better offerings, and in this they were not disappointed nor had they long to wait. Advances in price were made rapidly and with generous strides from the 3rd to the 10th of the month, when standard commercial blende held at $87 per ton base, with premium grades at $90 and the range on seconds and medium grade holding closely at $85 per ton base. From the 10th to the 17th, no material change was witnessed but the high tide of prosperity again rolled over the field from the 17th to the close of the month with the base price at $90 per ton, for premium and 60% ore and no changes on demand for the inferior grades. Refiners closed out entirely at the higher figures and profits were scored on a scale exceeded but once since the War sent spelter ore soaring skyward. The cleaning up of all high-grade product followed a sharp, if brief, season of accentuated competition between smelters that make a specialty of buying up only high-grade material readily convertible into metal. The less pretentious corporations represented in the field were practically squelched while the big boys were slamming each other around and the supposition was general among those well informed that the better prices were pulled down on 'gentlemen's' agreements to a greater extent than was given out for public consumption. Low-grade producers did not fare well the first half of the month, and then only found one of the large buying companies offering an outlet, the New Jersey Zinc Co. relieving a congested condition in camps where unidentified producers seek offers in open market. The output of the Linden district switched entirely to the Mineral Point Zinc Co. but it is pointed out here that the big eastern corporation is determined to freeze out the local refining company, and in this purpose seems to have succeeded admirably.

There was a considerable reserve of low-grade zinc ore found in the field at the close of the month but producers exhibited no anxiety regarding the future, the very atmosphere appearing surcharged with optimism. Much difficulty was experienced during the month in securing cars for immediate loading, especially in the Benton district where individual groups of mines made phenomenal weekly runs in ore recovery. This was exceptionally true of the Frontier Mining Co., which at times shipped as high as 20 cars of ore in a single week, and this under peculiar advantages guaranteed through contract arrangements with the Grasselli Chemical Co. The Frontier Mining Co. has been paying 24% dividends annually and in the past two years graciously contributes an extra 10% occasionally in addition to the generous liquidation just mentioned. The company paid $15,000 income State-tax for 1916 and has been exceeded in this respect by several of the other leading mining corporations now engaged in zinc mining in the Wisconsin field. An official of the Frontier Co. asserts, with mild reserve, that the mines now in operation for his company with new producers just brought up to shipping form will be producing 1000 tons of zinc ore concentrate weekly. The Frontier ores are all below 50% zinc assay but low-grade ores have been receiving distinguished consideration. One of the leading buyers of the field submitted offerings upon request as follows: 50%, $55 per ton base; 45%, $45; 40%, $40; 35%, $32; and 30%, $27. In matter of grades the Wisconsin field runs the gamut of all the grades quoted, with intermediate assays, and it is a safe assertion that the output of no two mines engaged in producing zinc ore in the Wisconsin field runs uniformly on grade, even on the same range.

The real sensation of the month was performed in the offerings made to lead-ore producers. The price at the beginning of the month held slightly in advance of $90 per ton, for 80% ore. The gains in quotations were made from day to day without recession at any time until in the closing days of the month offerings held at close to $125 per ton. The sold-up condition of the pig-lead market was mainly responsible for the extraordinary leaps accomplished in the markets but production has not kept pace with the demand and experienced miners claim now that it is not unreasonable to predict that lead ore will be commanding $150 per ton before midsummer. In the Wisconsin field producers cleverly resorted to waiting tactics, and even in the face of stiff advances refused to part with their product. Only as the price neared the high mark reported, did some consent to deliver and then only a portion of the ore held ready for shipment. The advent of spring weather will enable many small operating companies to invade shallow diggings for pocket and float-lead where washing can be conducted in the open.

Carbonate zinc-ore producers lost the only outlet for their product offered from outside sources, and such ore as was offered for sale was delivered through the ancient and honorable channel provided by the Mineral Point Zinc Co. Many small operators are engaged in rigging up plants for outdoor

cleaning and a better output is anticipated for this season. Pyrites remained in good demand at high prices, but the high offerings for zinc and lead ore, and the scarcity of cars for loading, determined refiners to devote themselves exclusively to the prompt shipment of zinc ore and several thousand tons of fines held at separating-plants were carried over.

Deliveries shown for the month of February, by districts, cover the period from the 1st to 24th, inclusive.

Districts	Zinc, lb.	Lead, lb.	Pyrite, lb.
Benton	20,000,000	152,000	.....
Mifflin	4,578,000	.....	.....
Galena	3,786,000	.....	.....
Hazel Green	3,282,000	.....	.....
Cuba City	3,184,000	.....	2,622,000
Linden	2,928,000	120,000	240,000
Shullsburg	2,328,000	.....	.....
Platteville	2,322,000	50,000	.....
Highland	560,000	.....	.....
Potosi	328,000	.....	.....
Montfort	172,000	.....	.....
Mineral Point	72,000	.....	238,000
Total	43,540,000	322,000	3,100,000

The gross recovery of concentrate of all grades for the month exceeded 40,000,000 lb.; net deliveries to smelters from refineries and from mines to smelter direct and under contract, 21,250,000 lb. The Mineral Point Zinc Co., operating with two reduction-plants, was tied up for a time overhauling buildings and machinery and did not make the fine showing for which this concern is noted, sending only 2,316,000 lb. of high-grade calcined ore to smelter at DePue, as against over 6,000,000 lb. delivered during the month of January.

Briefly summarized, the outstanding performances in the field during February find the northern districts acquitting themselves ordinarily while all the big doings are found in the camps south of Platteville. In the Cuba district the two refining-plants have been in constant operation with uniform results. Benton boasts several new producers and a big drilling-out program, by the Frontier Mining Co., that has resulted practically in the establishment of three new zinc ore producers: Bull Moose No. 2; Hird mine No. 1; and Hird No. 2, for which a complete rig will be provided to be in operation prior to June 1. For the Wisconsin Zinc Co. a new wet mill has been built at New Diggings at a cost of $10,000; a mammoth warehouse to store supplies for all mines, mills, refining-plants and boarding-houses. For the Vinegar Hill Co. a new producer was brought in with equipment and an adjoining property developed up to the producing stage to be connected with the Meloy mine and mill. The New Jersey Zinc Co. began the development of the Hoskins mine, also in the New Diggings. New producers are brought into co-operation with the Longhorn, C. A. T., and Champion mines, for the Wisconsin Zinc Co. The branch railway into this district will boom the district and give a great impetus to the opening of new properties. Whereas two years ago the camp was little known as a mining centre, today over 1000 miners find employment here, and there is a constant, as well as an insistent demand for more men, not less than 500 being required. The Shullsburg district is experiencing a re-awakening. The knockers have had their day and outside talent is beginning to assert itself. In the Galena district the new Birkbeck mine is performing steadily with good results. The Black-Jack and North Unity report regularly and the Graham mine, a new Vinegar Hill project, is having a tough water-fight that only time can bring to a successful conclusion. No changes are shown in the Hazel Green district. Never in the history of mining in this region has there been such activity as at present, and the outlook is for a long continued career of prosperous mining regardless of War conditions.

VIRGINIA CITY, NEVADA

CON. VIRGINIA AGAIN ATTRACTING ATTENTION.—ACTIVITY ALL ALONG THE COMSTOCK.

Important developments are being made on the Comstock Lode, and the outlook for the coming summer is more encouraging than it has been in many years. A short time ago a small vein was cut on the 2700-ft. level of the Consolidated Virginia mine, in the south-west drift from No. 2 west crosscut. Driving on this vein has shown it to increase in size and value. The assays, at first low in grade, have become higher as the work advanced, and now run from $5 to $20 per ton and over. Particular significance attaches to this new find, as it is in a large block of unexplored territory and its possibilities are considered great. In 1873 a vein was cut in a drift run north from the 1200-ft. level of the Gould & Curry mine that passed through the Best & Belcher and entered the Con. Virginia. This vein was small at first and the ore of nominal

COMBINATION SHAFT, COMSTOCK LODE.

value, but as the work proceeded the vein increased in strength and the assays began to mount. Soon it was worth $60 per ton, and later ran into the hundreds of dollars per ton. For two years development proceeded, blocking out the most wonderful mass of high-grade ore the world has ever known. With feverish activity the work proceeded under the direction of that astute superintendent, James G. Fair. The strike developed into the 'Big Bonanza,' and produced hundreds of millions of dollars. The stock increased so rapidly in value and to such high figures that, in order to keep it within reach of the speculating public, the property was divided into the Consolidated Virginia and the California mines, and the capital stock also was greatly increased, but notwithstanding this, the stock still had a market value in January 1875, as high, as $700 per share and that of the California mine $780 per share. The Big Bonanza was finally exhausted, but later a second ore-body—the 'Little Bonanza,' little only relatively—was found, and produced enormously. From the Big Bonanza the stockholders received: from the Con. Virginia $42,120,000 and from the California $31,050,000. It is not probable that the Con. Virginia has found another Big Bonanza, but miners who know the Comstock best hesitate to place any sort of limit to the possibilities of the great Lode—"they are," as Fair once said, "without limit, my son."

The Union is sending its ore to the Mexican mill, and is also milling ore from a stock-pile accumulated on the surface. Some excellent ore is coming from the 2600-ft. level of that mine. On the 2700-ft. level, exploration continues with encouraging results. The Mexican has placed an electric hoist on the 2500-ft. level at the winze to hoist from the 2900 level, and will begin development there as soon as practicable.

In the Sierra Nevada good headway is being made on the 2400, 2500, and 2600-ft. levels. There is some ore but thus far,

low-grade. The old Andes mine, lying up the slope back of the Con. Virginia is stoping ore on the 350-ft. level.

The Pumping Association is cleaning out the Mexican-Ophir winze to the 2900-ft. level and cutting out a station.

At the Gold Hill end, the Yellow Jacket is working ore from the upper part of the mine, and placing new equipment in the mill. The Alpha and Imperial are following small veins of rich ore on the 200-ft. level, working from the Imperial shaft. The Chollar-Potosi is being worked by the Comstock Leasing Company, it is said, with good results.

Everything considered, the future of the Comstock looks better today than it has for thirty years, and those interested are correspondingly jubilant.

WINNEMUCCA, NEVADA

IMPORTANT DEVELOPMENTS IN NUMEROUS MINES TRIBUTARY TO WINNEMUCCA.

The Helen Betty Mines Co. has installed pumps and other equipment at the Mazuma Hills and Mazuma Hills Extension mines, preliminary to extensive operations. The Darby mill has been placed in commission on ore from the dumps of the two properties. The mill has been completely overhauled and more equipment provided. The Helen Betty Co. recently took the mill and mines under bond and option. The property is at Vernon, in the Seven Troughs district.

Barret Springs, nine miles west of Winnemucca, is attracting attention, with several operators preparing for early shipments. The ores are largely silver-bearing, but in some instances a fair gold content is reported. Shipments will be to Winnemucca by mule-team or auto-trucks, and from here by rail to custom smelters.

The Seven Troughs Coalition Co. is working vigorously the Fairview gold mine, near Vernon. Arrangements have been made to install more machinery, and the shaft will be sunk deeper. On the 700-ft. level the main vein has been driven on for 100 ft. and shows a full width of milling ore, with seams of high-grade ore that will be shipped.

The Nevada Humboldt Tungsten Mines Co. has been formed to operate tungsten deposits at Mill City. The vein has been opened for 120 ft. by drifts from the main tunnel and is 5 ft. wide. It is said to assay 4% tungsten.

The long-awaited equipment for the tramway of the Rochester Mines Co. has arrived and within two weeks the management expects to be shipping ore to the mill by the new system. Northerly drifts from the 650-ft. level are in ore averaging 14 ft. wide, and the drifts from the 800-ft. level are showing wide faces of mill ore. North and south drifts above the 250-ft. level are advancing on a vein ranging from 6 to 7 ft. wide. The February output of the mine was $38,000.

MONTERREY, MEXICO

RENEWAL OF MINING AND SMELTING IN NORTHERN DISTRICTS OF MEXICO.

The renewal of mining and smelting operations in north Mexico is becoming general. The large smelter here of the American Smelting & Refining Co., recently re-opened with J. R. Enlow, formerly superintendent of the company's smelter at Chihuahua, in charge. Simon Guggenheim and Edward Newhouse, directors of the American Smelting & Refining Co., and C. L. Baker, general manager of the southern department of that corporation, arrived here a few days ago on a trip of inspection of the company's properties. They are arranging for the re-opening of the smelter at Matehuala, State of San Luis Potosi.

The American Smelting & Refining Co. plans to operate its own trains between Laredo, Texas, and Monterrey for the purpose of transporting to its plant here coke and otner necessary supplies, and to carry to the border the bullion from the smelter. The de facto government of Mexico has promised the company to exercise unusual vigilance in keeping this stretch of railroad open so that its smelter operations will not be hampered. Military protection is also to be given the different mining properties from which the smelter draws its oil supply.

The Mazapil Copper & Mining Co., which is controlled by American interests, resumed the operation of its smelter and mines at Concepcion del Oro, in the State of Zacatecas, a few days ago. The American employees of this company were

MAP OF A PART OF MEXICO.

driven out of Concepcion del Oro several months ago by bandits and the property has stood idle since then until it was recently re-opened. The Coahuila and Zacatecas railroad, which connects Concepcion del Oro with Saltillo, is under military protection of the governor and is to be kept open for the movement of traffic to and from the mining camp.

GRASS VALLEY, CALIFORNIA

NEW MACHINERY FOR ALLISON RANCH.—EXTENSION OF NORTH STAR MILL.

Two electric pumps are in position at the Allison Ranch mine and unwatering of the shaft will start with completion of the power-plant. The workings have been unwatered to a depth of 75 ft. Frank Vestal has resigned the superintendency of the cyanide-plant at the Empire mine to take charge of the Allison Ranch mill. As soon as the shaft has been placed in shape for mining, superintendent C. A. Brockington expects to employ 150 men.

Preparations are being made for substantial additions to the Central mill of the North Star Mines Co. It is probable 20 to

40 heavy stamps will be added to the 40-stamp unit, and capacity of the cyanide-plant also will be increased. The old 40-stamp North Star mill will be dismantled. A heavy tonnage of ore is being drawn from below the 6000-ft. level of the Central shaft.

The Signal Peak Mining Co. has installed a Cornish pumping-plant at its property, two miles west of Grass Valley, and sinking of the shaft 200 to 300 ft. deeper will commence at once. Some good ore is reported to be exposed in the old workings. E. M. Taylor is manager.

The Eastern & Main gravel property, situated on the Blue Lead channel, between Quaker Hill and You Bet, has been taken under bond by Issac Ostrom for $15,000. San Francisco capital is said to be chiefly interested. Driving of a bedrock tunnel has started from Greenhorn creek to drain the channel. A. H. Turner of Colfax is the principal owner.

The Columbia Consolidated Co. has arranged to double the capacity of its 10-stamp mill near Washington. Ten new stamps will be installed as soon as the roads are in shape for heavy transportation, and more tables provided. The mine force is to be increased. Manager C. E. Klinker reports the property to be in excellent shape.

SUTTER CREEK, CALIFORNIA

NEW VEIN OPENED IN CENTRAL EUREKA MINE.—OLD EUREKA MACHINERY ARRIVED.

Despite the heavy rains, resulting in increased water in the mine, the Old Eureka shaft has been cleared to the 1700-ft. level and it is estimated that within six weeks' the shaft will have been unwatered and in thorough repair. Below the 1600-ft. level the shaft later will be enlarged from one compartment to correspond in size to the upper portion, but as the timbers are practically intact after their many years of submersion, it was decided to leave the timbers unchanged until conditions at the bottom of the old shaft could be examined. The two new motors for the hoist have at last arrived at Martell station, but it will be impossible to haul them over the new road into the mine until the damage caused by the recent storm has been repaired. A large quantity of rock has been used on the road leading from the county highway to the mine, but the heavy rains have so softened the foundation of the road that difficulty is experienced in taking in ordinary loads, and these new 300-hp. motors each weigh five tons, the heaviest so far installed in the county. Proof of the early-day richness of the Old Eureka mine is furnished by the frequent discovery of 'high-grade' cached behind timbers as the shaftmen proceed downward with their work. One specimen recently brought to light is said to contain several hundred dollars worth of gold, while smaller finds are a common occurrence. The new transformers are about to be installed and everything will be in readiness to put the new hoist into operation when the motors can be placed.——The North Star shaft has been unwatered to the bottom; the rapid progress made in re-opening this old shaft being due to the timbers being found in excellent condition. In fact, it has not been necessary to entirely renew a single set, although the mine has been idle for more than 26 years. The only caves encountered were at the point where the cross-cuts on the 600-ft. level passed through the veins. These caves will quickly be caught up and work will be pushed vigorously in proving the value of the ore-shoots known to exist in the South Keystone group of claims. John A. McIntire of Sacramento, one of the directors of this new company, has been on the ground this week with manager Chas. H. Colpe, directing some important survey work pertaining to future cross-cutting and development. The surface plant works satisfactorily.

The two new 5-ton 300-hp. motors for the Old Eureka mine were delivered at the property during the week and are now in course of installation and the transformers are being connected up. Everything will be in readiness for the operation of the new hoist within a few days, after which the small hoist and temporary head-frame will be removed.

At the Central Eureka, the vein discovered in cross-cutting in the foot-wall for waste to use in filling stopes, is exceeding expectations both in size and value. This new orebody was unexpectedly cut on the 2500-ft. level and already has been driven on for 240 ft. and in that distance has given average assays of $6 per ton. Since the discovery of this ore, it has been handled through the 2700-ft. level by using the intervening stopes and chutes, but now the 2500-ft. drift, filled when that level was supposedly worked out, will be re-opened for the more convenient handling of the ore. The cross-cut run in from a point 15 or 20 ft. above the bottom of the shaft, which has just been sunk to 3400 ft., already has reached the orebody encountered in sinking a few weeks ago and the ore is giving excellent assays.

Sinking for the present has been discontinued at the Central Eureka mine, where the shaft has attained a depth of 3400 ft. A station will be cut in the new part of the shaft below where the ore was found in sinking. Driving on this rock will soon be commenced, and the usual raises made and chutes placed.

The intention is shortly to begin sinking for another level at the Oneida mine, of the South Eureka Mining Co. Ore of good grade is being mined from the lower levels and there is talk of increasing the milling capacity at the Oneida. A good grade of ore also is being mined on the 1200 and 1600-ft. levels of the South Eureka property and the 80 stamps of that mill are in steady operation.

SALT LAKE CITY, UTAH

MILLIONS IN DIVIDENDS BY THE JACKLING COPPER COMPANIES.

At meetings of the directors of the so-called Jackling properties held recently, dividends were posted amounting to almost $13,000,000, which will be distributed on March 31 to stockholders of record March 9. The dividends posted were on the Ray Consolidated, Chino, Utah Copper, Butte & Superior, and the Nevada Consolidated. With the exception of the latter two the dividends were the same as posted in December.

The Utah Copper will pay its stockholders the regular quarterly dividend of $2.50 and an extra of $1, which was the same as last quarter. This amounts to $5,685,517 or at the rate of $14 per share a year to $22,742,860. With the present dividend the Utah Copper will have paid its stockholders $57,901,493. Although shipments at the Utah Copper have fallen off during the past two months on account of the bad weather, the price received for copper has been higher so that the company is continuing to maintain its record of earnings which last year amounted to $26 per share and on which $12.50 in dividends was paid.

Chino Copper with 869,980 shares outstanding pays its stockholders $2,174,950 or at the rate of $1.50 the regular quarterly amount, and an extra of $1. This is the same as that paid during the previous quarter.

Ray Consolidated will pay its usual quarterly dividend of 75 cents and an extra of 75 cents, the same as last quarter. This amounts to $2,365,693.50 on the 1,577,129 shares out.

The Nevada Consolidated reduced its extra dividend. This quarter it will pay the regular dividend of 50 cents per share and an extra of 50 cents per share. Last quarter the extra was $1. This amounts to $1,999,457.

Butte & Superior also reduced its extra dividend. The last extra was $5. The dividend posted today is the regular of $1.25 and an extra of $1.25 making a total of $681,742.50 to be distributed to the stockholders.

The grand total of the properties posting dividends amounts to $12,907,558.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALABAMA

Graphite properties near Pyriton, will be developed by the Great Southern Graphite Co., and the plant will have a daily capacity of 300 tons. The machinery has been purchased, and 120 acres will be mined. Officers have been elected as follows: H. O. Moore, president; F. J. Holberg, secretary; John D. Hutton, treasurer; A. W. Clark, general superintendent; Edward B. Van Keuren, construction engineer; all of Birmingham.

ALASKA

The copper ore shipped from Alaska in February is stated to have been worth $4,099,001; lead ore, $11,295; gold ore, $182,667, and silver ore, $76,472.

A shipment of 250 tons of tungsten ore from Alaska was sold to the Bilrowe Alloys Co. of Tacoma. This company is building electric furnaces for the manufacture of special alloys at Tacoma.

SEATTLE. The impression prevails that the next big placer stampede in Alaska will be to the Kuskokwim valley. A recent strike was made on Quin Hagak creek, where a miner took out $800 in ten days, says the *Seattle Times*. Two natives assisted him. Good strikes have also been made on Canyon and Bear creeks in the same region, about 80 miles up the river from Bethel. This is according to Duncan McMillan, who recently came from that district

"It is contrary to the policy of the trading companies in the Kuskokwim valley," says McMillan, "to have any news of strikes get to the outside world. I know very little about mining, but I believe that the country some day will support a great population. The natives and Laplanders are doing splendidly with their reindeer herds. Besides indications of placer gold, there are other minerals." Mr. McMillan has a cinnabar mine 125 miles up the river from Bethel. He says he was offered $300,000, but is holding it for $500,000.

ARIZONA

(Special Correspondence.)—The New Cornelia Copper Co. announces the opening of its town-site to the public. The town-site will be operated by the Ajo Improvement Co.

Ore shipments continue from the Hill No. 3 to the C. & A. smelter, at Douglas, at the rate of about a car a day, three shifts being employed.——Sam Clark, owner of the C. & A. No. 2, announces a strike of native copper on that claim. He is operating the C. & A. No. 2 and several other claims in the vicinity.

Mr. Gotthelf, of Los Angeles, is here inspecting the Mandan group with a view to lease or purchase the property.

Ajo, March 2.

CAVE CREEK. E. A. Howard is about to resume work on the Morman Girl mine, at Cave Creek, in Maricopa county.

BISBEE. The Bisbee-Tombstone Copper Mining Co. is preparing to sink two shafts on its property west and north of the Warren district. One shaft is already down 50 ft. The other shaft will be sunk on the other side of the hill several hundred feet from the first.

JEROME. There is an unconfirmed report in circulation that in the Jerome Verde a mass of high-grade copper sulphide has been penetrated by a diamond-drill operated in the United Verde Extension Co.'s Little Daisy claim, on the 1400-ft. level. The new find is supposed to be the continuation of the orebody which was lost by faulting in the Extension mine. It is said that the ore runs from 15 to 20% copper.

KINGMAN. The first shipment of molybdenite concentrate was made from the Leviathan mill in Copper canyon March 3, the shipment going to San Francisco. The Leviathan company has a mill of 60 tons daily capacity, and has been making a 40% product. As soon as the weather moderates a larger output of concentrate will be made, the mill being handicapped by freezing water. Sinking below the 100-ft. level will soon be started. The mine is looking well. The orebodies have been opened 500 ft. long, without finding a break.

MIAMI. The Inspiration company during February hoisted a daily average of 18,269 tons of ore.

(Special Correspondence.)—A. C. Werden, manager of the Gold Ore Mining Co., reports successful tests by flotation at the laboratory of the Minerals Separation Co. at San Francisco. Tests show a concentrate of 30 tons into one and an extraction of 95%. The mill costs are estimated at $1.50 per ton in a plant treating 100 tons daily, including royalty. Minerals Separation Co. claims to treat flotation concentrate, at a cost of about $1 per ton, which would be less than 5c. per ton of crude ore. If this can be demonstrated to satisfaction of the Gold Ore Co. it is probable that the flotation-process will be installed. The cost of a 100-ton plant is estimated at $45,000, which is less than one-half the cost of a cyanide mill of the same capacity.

The Big Jim cross-cut on the 600-ft. level has cut the vein and encountered a heavy flow of water that delayed operations. The vein was cut where the engineers had estimated, indicating that the dip and course are unchanged. It will require several days to drain the accumulated water on the 500-ft. level as well as the natural flow of the pent-up water in the vein below the 500-ft. level. Much interest attaches to the 600-ft. level, which Horace V. Winchell stated probably will double the value of the estimated ore.

Work has been resumed at the Telluride which adjoins the productive easterly end of the Tom Reed, where a large vein of high-grade milling ore has been developed on the Aztec Center claim. The Telluride has a strong vein which was prospected at a depth of 500 ft. The shaft will be sunk an additional 100 ft. Three shifts are employed under direction of J. H. McIver, who opened the ore in the United Eastern.

Shipments of bullion were made early in the week from the United Eastern and Tom Reed mines. The value of the two shipments, representing two weeks' run of the two mills, exceeded $100,000.

Oatman, March 5.

(Special Correspondence.)—A strike of chalcopyrite is reported on the Mile Wide Copper Co.'s property in the Tucson mountains. The ore averages 20% copper and the vein is 8 ft. wide on the 200-ft. level. Supt. C. E. Visel is driving along the shoot and will raise and sink. The controlling interest in this property is held by the Lyon, Singer Co. of Pittsburg.

Tucson, March 2.

CALIFORNIA

CARRVILLE. The Pacific Gold Dredging Co. is preparing for construction of its No. 2 dredge, which will operate on Coffee creek. It will be of same size and type as No. 1 which has been working for several months with satisfactory results.

DOWNIEVILLE. Work in the Gold Bluff-Oxford mine is to be

resumed, the owners of the Gold Bluff having agreed to extend the time for a payment on the bond.

DOWNIEVILLE. A bond has been given J. G. Sartorius by H. S. Tibbey et al, owners of the Brown Bear gravel property, on St. Charles Hill in Sierra county. By the terms of the bond, work must be commenced not later than May 15, 1917, and at least two shifts of miners must be employed; the wages of the employees and all bills must be paid at least monthly (they may be paid semi-monthly if desired) and the owners of the property are not to be held liable, under the employers liability act, for the injuries or death of any of the employees. The bond was given in February and was put on record by Mr. Sartorius last week. The bonder is a resident of San Francisco.

(Special Correspondence.)—FOREST CITY. Under the management of W. F. Copeland work in the Bald Mountain and Bald Mountain Extension properties is being vigorously carried on. The Bald Mountain tunnel has been cleared for 1200 ft. and a cross-cut from this point has intersected an 18-in. vein of sulphide ore. The ore occurs in amphibolite, near the serpentine contact. Prospecting of the gravel channel is also in progress. The continuation of the Bald Mountain Extension channel is being explored by a tunnel from Rock creek. The mines lie near Forest City.

The tunnel at the Kanaka mine, near Alleghany, has advanced to a point 300 ft. in from the portal and is calculated to intersect the vein within 50 ft. On surface the vein shows a width of 18 ft. of fair-grade ore. A one-fourth interest in the property has been purchased from Ambrose Madden by Paul Proper of Oakland.

DOWNIEVILLE. The Rosenfeld Co., of San Francisco, has granted an extension on the bond of the Gold Bluff-Oxford group, according to word from the operators. The group has been under bond and option to Salt Lake capitalists for two years, in which time much development work has been performed and equipment installed. The property is near Downieville.

Downieville, March 9.

GARDEN VALLEY. The chrome mine in Garden Valley, which was closed on account of the bad weather, is being again worked. Several teams are hauling the chrome to the railroad at Placerville.

(Special Correspondence.)—The Rand Mining Co. of San Francisco that is working the June-Ione tungsten mine on Slickrock creek eight miles north-east of Glenville, in Kern county, is equipping the property with a concentrating plant costing $30,000, and having a capacity of 50 tons of ore daily. They estimate the average content of scheelite at 2%. A shaft has been sunk 40 ft., and an adit run on the vein 60 ft. Development is in progress. Work is to be resumed on the Cadillac group on the middle fork of Cedar creek, two miles north-west of the June-Ione. The scheelite in both mines is associated with garnet.

Glennville, March 4.

GROVELAND. A washout on the Argall ranch, at Second Garotte, three miles east of Groveland, on the Yosemite road, uncovered a quantity of gold. Without doing any mining work, the owner of the place picked up gold to the value of $600 in the trench cut by the water. He will work the ground miner fashion, and expects to locate the source of his new-found wealth.

HODSON. The directors and principal stockholders of the Royal Consolidated mines are endeavoring to re-organize the company with a view to resumption of operations, and to make an arrangement whereby the creditors may be satisfied.

OROVILLE. Horace Onyette has been recruiting a force of experienced dredge-men for service on dredges at Iditarod, Alaska.

PLACERVILLE. It is reported that the Church-Union mine, together with some adjoining property, five miles south of Placerville, has been sold to H. H. Long of Mill Valley, Cal. The old Church-Union mine has been working for several months past, after years of idleness. It is said the old Springfield mine, half a mile south of the Church-Union is also to be unwatered. The Springfield mine was last operated by A. Harpending, nearly 20 years ago.

WASHINGTON. C. E. Klinker, general manager of the Columbia Consolidated Mines, is to add ten stamps to the Ocean Star mine and as soon as weather permits will double the force of men.

The report of State Oil Inspector, R. P. McLaughlin, for the week ended March 3 shows 24 new oil-wells started, 20 to be inspected for the test of water shut off, 23 being drilled deeper or re-drilling, and four to be abandoned.

Articles of incorporation of the Cerise Gold Mining Co. of Willows, Glenn county, organized for carrying on a general mining and milling business, have been filed in the Secretary of State's office. The incorporators are: Z. E. Simpson, Orland; H. E. Simpson, Orland; Frank Freeman, Willows; Charles L. Austin, Wilbur Springs; and John Schribner, Orland.

In 1914 the New Idria Quicksilver Co., in San Benito county, received an average price of $48.31 per flask for its quicksilver. In 1915, due to the increase in demand, the company received an average price of $74 a flask. In 1916 the price received was $89.57 a flask. That is more than double the average price received in 1913. It cost New Idria Quicksilver Co. between $47 and $48 a flask to produce its quicksilver.

The following applications have been made to the State Water Commission for the appropriation of water for mining purposes:

John Terribilini, of San Bernardino, 40 miner's inches of the water of a tunnel in a mountain in Riverside county for gold-mining purposes.

Byron N. Russell, of Weed, 3 cu. ft. per second of the water of Dutch creek tributary to Beaver creek in Siskiyou county, for placer mining. It is proposed to conduct the water three and one-half miles by a ditch from the point of diversion to the place of use at a cost of $1000.

The Table Rock Mining Co. of Table Rock, 400 miner's in. of the water of south fork of Slate creek tributary to Slate creek in Sierra county for purposes of sluicing gravel. A ditch 1096 ft. long will be required to carry the water to the place of use.

COLORADO

The Gilpin County Mining Association has taken up the problem of the relation of the small ore-shippers to the smelter, with a view to securing legislation that will define more clearly what the ore-shipper is entitled to receive from the smelter and what the charges for treatment shall be. A shaft is also aimed at the 'time-honored' practice of the smelters converting to their own use minerals in the ores for which no accounting whatever has been made in the past.

LEADVILLE. The new ore-shoot recently found in the Ontario tunnel, near Leadville, has been cut for 40 ft. in the drift. It is believed that another shoot lies about 100 ft. farther on, that was passed through by the Tiger shaft, in the early days of the district.——The Jamie Lee has suspended operations until additional pumping facilities can be provided. The shaft was down 601 ft. when the last heavy flow of water came in. Diamond-drilling is in progress on the lowest level of the mine, not far from the shaft. The sudden heavy influx of water is regarded as indicative of the proximity of ore.——The leasing company operating the Fortune mine below the level of the Yak tunnel also has a heavy flow of water that is believed to come from some old workings. A sinker in the Resurrection winze is lowering the water in the Fortune workings.

(Special Correspondence.)—The Gold Crown mine is nearly

ready to commence operations.——The Mineral Farm will again be in operation next month and the manager C. R. Wilfly looks forward to opening up good orebodies and hopes to solve the peculiar problem of the ore conditions. It means big things or nothing on Mt. Hayden.——The Mountain King property under lease to Sheriff Krisher, is a steady shipper of lead and zinc ore and as the mining of the same requires no powder, it makes the mining cheap.

Ouray, March 1.

Silverton. An important development is reported made in the Pride of the West mine, where a large vein of ore running 55 oz. silver, $70 in lead, and $20 in gold has been struck. The main adit was run 2000 ft. years ago, and when, after a long idleness, work was resumed last fall, a good deal of repairing and cleaning up had to be done. Then a drift was started from a raise in 1250 ft. from the portal, with the result stated. Ore has been hauled on sleds to the new Green Mountain mill during the winter. The Pride of the West and the Green mountain mine are both under the management of A. W. Harrison. The mines are in Cunningham gulch, six miles from Silverton. Slattery, Delsant & Gillette, lessees of the Highland Mary mine, have made repairs and the necessary changes in the mill, and will begin milling ore about March 10. During the winter they have packed their ore to the railroad for shipment to smelters.

IDAHO

The output of Idaho's mines in 1916 reached a total of $49,102,693, which is the largest and highest for a year in the history of the State, according to the official report of Robert N. Bell, State inspector of mines.

The metal content of the mineral and bullion shipped, from statistics available, is as follows:

Lead, pounds	366,594,000
Zinc, pounds	98,700,740
Copper, pounds	8,052,725
Silver, ounces	12,205,132
Gold, ounces	58,079
Tungsten ore, pounds	120,000

These figures are based on gross metal-contents of the ore as shipped, without discounting for loss in smelting, which is a variable amount and hard to determine and to some extent made up with by-product recoveries that are not paid for by the smelters.

These figures maintain Idaho in second place in lead production among the States of the Union and are a splendid indorsement of the progress and permanence of the mining industry in this State.

The estimated dividend distribution of the year aggregated about $11,500,000, which is more than the total output of the State as recent as 15 years ago and was credited to 14 mines, nine of which are lead-silver and zinc producers in the Coeur d'Alene, and five in south-central Idaho, situated in Boise, Blaine, Custer, and Lemhi counties, and include a gold, a copper, and three silver-lead producers. That the dividend distribution was not larger is due to enormously increased operating costs, including labor and material. The operators of northern Idaho volunteered an advance in wages based on a sliding scale.

During the year there were employed in mining and milling operations, according to statistical reports received by this department, with a conservative estimate of the remote parts of the State, 7500 men, of which 5300 are credited to Shoshone county.

The total fatalities were 13. The number of serious accidents, involving a loss of time in excess of 14 days, was 219. The number of minor accidents, involving less loss of time, was 672.

In the three months of operations ended February 28 the Rex Consolidated Mining Co., operating in the Coeur d'Alene produced 2200 tons of concentrated ore. Raymond Guyer, general manager, says that the net profits on this ore were $53,000. The greater part of the product was shipped to the leaching plant of the Anaconda Copper Mining Co. at Great Falls. The rate of milling will be increased to 275 to 300 tons daily by the end of March.

Extraction has been high, averaging about 86%. The concentrate contains 35% zinc, 11% lead, and 5.2 oz. silver to the ton. Another product contains 48% lead and 19 oz. silver to the ton.

KANSAS

Baxter Springs. The Lucky Kid Mining Co. has bought 40 acres of the Hocker land, three and one-half miles south-west of Baxter Springs. This company includes in its personnel J. M. Smith of Webb City; J. G. Marcum, of Joplin; W. A. Moses, L. E. Moses, and A. L. Harroun, of Kansas City. Over a year ago it acquired the lease just east of the Montreal mine at Century, and recently has been making heavy turn-ins from this property. On the Hacker lease drilling indicated the presence of 40 ft. of ore at a depth of 160 ft. Assays run from 10 to 40% blende.

MICHIGAN

During 1916 the copper content of the ore of the Mass Consolidated increased 2 lb. per ton—from 14.35 to 16.51 lb. Even this advance, however, does not bring it to a point where it could be considered an average Lake Superior mine. The only three mines of importance in that district, whose yield per ton was less than that in 1915, were the Centennial, Isle Royale, and Osceola. The only one which has been a money maker is the Osceola, which has been able to do so because of the large tonnage of rock that it handles.

Treating 300,000 tons of ore per year, Mass Consolidated could hardly hope to get its cost down to less than 12c. per pound on rock of this grade, even under normal conditions. This would mean earnings on a 5,000,000-pound output of about $1.50 per share on 15-c. copper. However, the fact remains that the change was in the right direction.

MINNESOTA

Two leases of iron mines of the Great Northern ore properties in northern Minnesota, involving an estimated consideration of $110,000,000 have been sold to the Inland Steel Company and Jones & Laughlin of Pittsburg, according to a story printed in the St. Paul *Dispatch*.

MISSOURI

Galena. The largest zinc-ore shipment that has been made from the Galena district for many years was made last week, and consisted of 30 cars. The record turn-in has not been approached for more than three years, when 25 cars were sent out.

The George McCullagh Mining Co. made the largest shipment, with nearly 250 tons, and several other companies made large shipments.

There was a brisk demand for low-grade ores last week. The Empire Mining Co. sold ore for shipment before March 10 that assayed only 40% metallic zinc. The ore contained 18% iron and was sold on a basis of $80 per ton.

Most of the ore sold brought $85 per ton. The James Murphy Mining company received $88 for its ore, and that price is believed to have been the record for the week here.

Lead sales totaled more than 105 tons. They were made in small lots and the Southside Mining company made the largest lead turn-in, with a little more than nine tons. Lead brought $115 per ton last week.

Mansfield. The R. S. & T. Mining company sold two carloads of silicate last week to a Joplin buyer.

The Mansfield district has a revival of mining, due to re-

cently discovered rich land near the town. Years ago a little lead mining was done, but blende and silicate is a new discovery.

The R. S. & T. company has 1600 acres of land in the ore belt. Surveyors are laying off the land into 40-acre tracts, which will be leased to prospective mining companies. Other companies have been formed and promise to place Mansfield on the map as an ore producing district.

The R. S. & T. company is installing new machinery in a mill on its lease and soon will be in a position to increase its ore production to a considerable extent.

MONTANA

BUTTE. Progress has been made in the bulkheading of shafts in the West Colusa, Tramway and Leonard mines to check the destruction by the fire in the workings of the latter property. The blaze and the resultant gases are daily being confined to smaller and smaller areas. The situation is well in hand, but the fire is resulting in a decrease in the normal production of 900 tons of ore each day at the Leonard and West Colusa.——Many men are constructing bulkheads on the lower levels of the Tramway, but the full production of 1500 tons per day could be kept up should the weather moderate sufficiently to make it possible to handle the ore, says John Gillie, general manager of the A. C. M. properties in this community.

The regular output at the Leonard is 1300 tons per day and of the West Colusa is 1400 tons daily. One-third of the production at each of these has been decreased because of the fumes from the fire in the Leonard, thought to be the appearance on lower levels of the great blaze which started in the mine in 1906 and which was thought to have been safely confined behind bulkheads.

LIBBY. During January the Rose Consolidated recovered gold worth $3000, and tungsten $2000, from 25 tons of ore daily. The extraction was 85% of the gold and 75% of the tungsten.

MARYSVILLE. The Boyer Bros., who have been prospecting and mining here for years, recently began prospecting near the Gloster-Piegan group of claims and north toward the Big Ox group, and have uncovered a blind lead. After sinking to a depth of 15 ft., the ore was found to be 6 ft. wide, 3 ft. of which assays $50 gold per ton, and 3 ft. of it $10 per ton. The Boyers sold their new find to the Barnes-King Co. for $50,000, receiving part cash, the remainder to be paid by January 1, 1918. The ore is free-milling and its situation is good as regards milling facilities.

NEVADA

COALDALE. The development of the coal seams at Coaldale, 40 miles north of Tonopah, is to be undertaken by the Darms Coal Mining Co. There are known to be several veins of coal in the field, one of which is 2 ft. thick where cut in a shaft at a depth of 428 feet.

GOLDFIELD. Leasing was popular here in the early days of the district and to it was due the surprisingly rapid development of the mines. Later the principal properties were consolidated and controlled by a few companies. As the great mines began to show unmistakable signs of exhaustion, leasing has been again resorted to, and with gratifying results. The Goldfield Consolidated is leasing parts of its ground; the Florence has 14 blocks operating under lease, and other mines are being similarly worked, though on a smaller scale. The improvements in the flotation annex of the Goldfield Consolidated are completed, and ready to treat an increased tonnage of ore. In the Atlanta mine, A. I. D'Arcy, the manager, reports that a 5-ft. vein of ore has been opened for 100 ft. Of this 18 in. assays $130 in gold and silver, and the remainder is worth $38.

GOLDFIELD. In January the Goldfield Consolidated Co. mined 26,500 tons of ore at a net profit of $19.50. During the month 1718 feet of development work was done. Operating costs were as follows:

	Ore handled, c. per ton	Total ore, c. per ton
Mining:		
Stoping	2.430	.....
Development	28.388	.....
Total mining	2.760	2.456
Shipping expense	.....	.....
Leasing expense	.....	.002
Dump moving	.360	.040
Transportation	.068	.068
Milling	2.013	2.013
Marketing	.024	.024
General expense	.330	.330
Bullion tax	.016	.016
Filter royalty	.050	.050
Flotation royalty	.045	.045
Surface	.049	.049
Total operating costs		5.093
Miscellaneous earnings		.181
Net operating costs		4.912
Construction		.....
Net costs		4.912

MANHATTAN. The new roasting and cyaniding equipment now being built at the White Caps mine will be completed and ready for operation early in June. The recent development in the White Caps mine is reflected in the activity of Manhattan stocks in the stock market.

The *Tonopah Miner* reports for the week ended March 3, that the Tonopah Belmont sent to the mill 2920 tons, the Tonopah Mining 2300 tons, the Tonopah Extension 2380 tons, the Jim Butler 750 tons, the West End 677 tons, the Rescue 255 tons, the Halifax 161 tons, the Montana 80 tons, the Midway 56 tons, the MacNamara 53 tons, and the North Star 53 tons, making the total production for the week 9685 tons, the estimated value being $174,330. This valuation is calculated on the gross milling value of the ore.

TYBO. Seventy-five miners are to be put to work as soon as possible by the Louisiana Consolidated Mining Co. at the old Tybo mine, in Nye county. This property was acquired from the old Nevada Mines and Smelting Corporation, which produced $5,000,000 between the years 1872 and 1879. The property consists of 125 acres. The shaft is 420 ft. deep, but practically all the ore that was extracted came from above the 300-ft. level. Barney Baruch & Co. is said to be the financial backer of the enterprise. A number of tractors and trailers will be used in hauling ore. There is en route a 165-hp. semi-Diesel engine, which will operate the compressor and pumps. Within two months it is expected that the property will be in full operation.

SOUTH CAROLINA

E. P. Earl & Sons have taken an option on several mines in the Ore Knob district and are planning development of the properties. Their office is at 165 Broadway, New York.

SOUTH DAKOTA

DEADWOOD. The Minerva mill, that for 40 years has stood near the mouth of Blacktail gulch, is being torn down and the machinery moved to the Custer Peak Company's mines near Englewood. The mill was first built to work the auriferous conglomerate of the Minerva mine, that is situated on the north side of the gulch joining the Gustin mine.

TENNESSEE

The Ocoee Copper Co., with a capital of $1,230,000, has been incorporated by J. I. Carter, W. N. Whitaker, J. D. Mitchell,

I. G. Phillips and Raymond Wallace, all of Chattanooga; they have acquired 124 acres of copper-ore lands, and have leases on other similar property in Polk county. They have found high-grade ore in four places on the property, by means of the diamond-drill. They will sink a shaft and build a smelter.

TEXAS

(Special Correspondence.)—The mining of Fuller's earth is to be undertaken on a large scale near here by the Medina Fuller's Earth Co., which was recently incorporated with a capital stock of $100,000. The company is headed by L. R. Parker of Aurora, Illinois, and associated with him are E. D. Henry and O. T. Gregory of San Antonio. They own 160 acres of land 14 miles west of the city, upon which there is a large deposit of fuller's earth. It is planned to install machinery and other equipment to cost $50,000 for developing the property.

San Antonio, March 5.

UTAH

The Utah Copper Co. has $15,000,000 cash on deposit to its credit. During January and February the earnings of the company averaged $1,000,000 per week.

EUREKA (Tintic Dictrict). A new strike of lead carbonate ore is reported in the Lehi-Tintic mine, in North Tintic. The deposit is known to be 30 ft. wide and 8 ft. thick. It is worth $25 per ton.——The Sioux Consolidated is cutting stations on the 800 and 1000-ft. levels, preparatory to driving to the body of copper ore that is believed to extend into this property from the Iron Blossom.——The Mammoth mine will resume shipments of ore as soon as the railroad can supply cars. The ore is high-grade.——The Lower Mammoth is mining lead-silver ore on the 1500-ft. level, and copper ore on the 1000-ft. level.——At the Victor mine, Earl McIntyre is shipping low-grade copper ore, which was dumped into the stope on the 300-ft. level for filling.——A strike was made recently in the Chief Consolidated mine on the 1800-ft. level, and high-grade ore is being mined. The output is 15 tons daily of ore running 800 to 1000 oz. silver.——The Gold Chain mine has 35 railroad cars of ore on hand waiting for cars which the railroad has been unable to furnish.

PARK CITY. Operators of the mines in Park City have posted notices of a raise of 25c. per day for all the men, the date of advance being March 1. Some months ago it was generally understood that when silver advanced to 75 cents or better there should be a raise in salaries. This was in compliance with statements made by various operators at times when metals were down.

The scale formerly paid was $3.50 a day for shovelers, $3.75 a day for machine-men, $4 a day for timber-men, and $4.50 a day for engineers.

Leaving out the lessees, there are approximately 1000 men employed in the mine and mills of the camp, the principal active properties being the Silver King Coalition, the Daly Judge, the Daly West, the Ontario, the Silver King Consolidated, the Naildriver, the New Quincy, and the California-Comstock.

WYOMING

The Copper Corporation has been organized to exploit copper deposits at Shawville. E. D. Miller is president, and S. C. Snead is secretary and treasurer.

CASPER. The Hall Oil Co. has spudded-in a new well on the north-west quarter of Section 22, Township 3, Range 1 West, in the Pilot Dome field, and the progress of this well in particular will be watched with interest by all who are acquainted with that oil territory. Otto Stock, of Casper, has the contract, which calls for drilling to a depth of 3000 ft. It is being done with a California standard rig that was erected and put into service last week. The machinery is well housed and heated and an abundant water supply is available.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

CHARLES BUTTERS is in New York.

MARK B. KERR has returned from San Sebastian, Salvador.

WALTER G. PERKINS has arrived in New York from London.

FRED. SEARLS, JR., has returned to San Francisco from China.

EDGAR RICKARD attended the meeting of the Canadian Mining Institute.

HOWLAND BANCROFT has been inspecting mines at Oatman, Arizona.

W. L. WHITEHEAD has gone to Antofagasta, Chile, on a geological expedition.

RUSH T. SILL, of Los Angeles, has been in the Gold Reef district of California.

HENRY HAY has returned from Chile and is now at Long Branch, New Jersey.

WILLIAM B. DENNIS, of Corvallis, Oregon, was in San Francisco for a few days.

ALEX. BAIRD has been appointed assistant mine inspector for the State of Nevada.

D'ARCY WEATHERBE passed through New York on his way from London to Cobalt.

W. H. SEAGRAVE, recently resident in New York, has established himself at Seattle.

THOMAS S. CHALMERS, of Chicago, passed through San Francisco on his way to El Paso.

N. H. RUBY has gone to Mexico to take charge of a molybdenite mine near Magdalena.

R. J. JOHNSTON has returned to El Paso from the Creston-Colorada mine, in Sonora, Mexico.

A. F. KUEHN, director and acting manager of the Burma Mines, is here on his way to London.

SAMUEL S. FOWLER passed through San Francisco on his way from British Columbia to San Diego.

J. H. COLLIER, of Oakland, is on his way to New York and Montreal, preparatory to going to Alaska.

JOS. S. HENRY, of Castlemaine, Australia, is visiting California, after a professional engagement in Bolivia.

H. R. VAN WAGENEN, of Denver, Colorado, has left for Chile on examination work. He will be absent from the United States until about July 1.

WILTON J. CROOK has resigned the position of Professor of Metallurgy in the South Dakota School of Mines to re-enter the employ of the Pacific Coast Steel Co. at South San Francisco.

PETER NISSEN, the inventor of the stamp that bears his name, is also the inventor of the Nissen hut, now in general use by the British army in France. He is a major and was recently awarded the D. S. O. for distinguished services.

THE deliveries of tin during February were fair, amounting to 3930 tons, of which 680 tons came via Pacific ports. Incidentally it may be said that shipments via Vancouver, B. C., are increasing for the reason that it is becoming more and more difficult to obtain cargo space at Singapore for direct shipment to New York. It has been ascertained that shipments to New York from the Far East by way of London not only have to encounter the submarine peril, but in addition have to pay double insurance at high rates. There is one insurance cost to London, and another to the United States. At the same time, importers are not cheered by the Vancouver shipments because of the long delays and the impossibility of keeping informed as to where the metal is.

THE METAL MARKET

METAL PRICES

San Francisco, March 13.

Antimony, cents per pound	24
Electrolytic copper, cents per pound	38
Pig lead, cents per pound	9.50—10.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$100—105
Spelter, cents per pound	13
Tin, cents per pound	50
Zinc-dust, cents per pound	18—20

ORE PRICES

San Francisco, March 13.

Antimony, 50% metal, per unit	$2.00
Chrome, 40% and over, f.o.b. cars California, per ton	18.00—20.00
Magnesite, crude, per ton	8.00—10.00
Tungsten, 60% WO_3 per unit	18.00—18.50
Manganese, 50% (under 35% metal not desired)	29.00

Manganese ore, 40 to 45%, sells f.o.b. Chicago at 58c. per unit with a penalty of 50c. per unit for more than 8% silica.

EASTERN METAL MARKET

(By wire from New York.)

March 13.—Copper is unchanged. Lead is easier at 10 to 10.25c., with market firm. Spelter is quiet and steady.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date.		Average week ending	
Mch. 7	75.50	Jan. 30	75.87
" 8	75.37	Feb. 6	76.79
" 9	75.12	" 13	77.62
" 10	75.12	" 20	78.41
" 11 Sunday		" 27	77.37
" 12	75.00	Mch. 6	76.50
" 13	74.25	" 13	75.06

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	48.85	56.76	75.41	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	....	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

The stock in Shanghai on February 3, 1917, consisted of about 23,000,000 oz. in sycee and $17,700,000, as compared with about 23,400,000 oz. in sycee and $16,700,000 on January 20, 1917.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date.		Average week ending	
Mch. 7	36.25	Jan. 30	31.91
" 8	36.25	Feb. 6	33.00
" 9	36.25	" 13	33.90
" 10	36.25	" 20	35.37
" 11 Sunday		" 27	36.00
" 12	36.25	Mch. 6	36.29
" 13	36.25	" 13	36.25

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	....	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

Copper sales last week totaled about 25,000,000 lb. Practically all of this metal was purchased by domestic consumers, and the major part of this business covered third quarter delivery.

The Braden Copper Co. in February produced 3,450,000 lb. of copper; the Kennecott Co., 7,090,000 lb.; the Shannon Co., 759,000 lb.; Anaconda, 25,000,000 pounds.

Shattuck Arizona dividend of 50 and 75c. extra will be paid quarterly, dates April 30 and March 31, July 20 and June 30, October 20 and September 29.

Butte & Superior, $1.25 and $1.25 extra. Three months ago it was respectively $1.25 and $5 extra. Payable March 31 to stock of record March 9.

Utah Copper, $2.50 and $1.50 extra. Payable March 31 to stock of record March 9.

Chino, $1.50 and $1 extra. Payable March 31 to stock of record March 9. Three months ago the same.

Ray Consolidated, 75 and 25c. extra. Payable March 31 to stock of record March 9. Dividend same as three months ago.

Nevada Con., 50 and 50c. extra. Three months ago it was 50c. and $1 extra. Payable March 31 to stock of record March 9.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date.		Average week ending	
Mch. 7	9.50	Jan. 30	8.02
" 8	9.50	Feb. 6	8.41
" 9	9.50	" 13	8.60
" 10	9.50	" 20	9.58
" 11 Sunday		" 27	9.45
" 12	9.50	Mch. 6	11.54
" 13	9.50	" 13	9.50

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	....	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date.		Average week ending	
Mch. 7	10.87	Jan. 30	10.41
" 8	10.87	Feb. 6	10.06
" 9	10.87	" 13	10.52
" 10	10.87	" 20	10.54
" 11 Sunday		" 27	10.70
" 12	10.87	Mch. 6	10.85
" 13	10.87	" 13	10.87

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	....	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Date.		Feb. 27	135.00
Feb. 13	140.00	Mch. 6	115.00
" 20	140.00	" 13	105.00

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	....	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly averages

	1915.	1916.	1917.		1915.	1916.	1917.
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	....	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

ALUMINUM

Quotations remain unchanged at 57 to 59c. for No. 1 virgin aluminum, 98 to 99% pure. The market is quiet.

ANTIMONY

Ore from South America is being offered for the first time since the break in prices last year. March shipment is quoted at $2.30 per unit.

ORES

Tungsten. The tendency is toward higher prices, largely for the reason that stocks are low, with stocks en route to New York already under option. Wolframite has brought $17 per unit. Supplies coming from South America are small for the reason that the Entente Allies are buying direct in Argentina, Peru, and Bolivia. A six months' contract is reported to have been closed in South America at prices equivalent to $16.65, f.o.b. South American shipping-point, and further negotiations are in progress. Ferberite and scheelite have brought $18 per unit according to a dealer.

Molybdenum. There is a shortage of ore which has put the makers of ferro-molybdenum behind in their contracts. Business in wulfenite is reported as $2 per pound.

Antimony. Uncertain shipments from South America make business precarious. The quotation is $2.30 per unit.

Eastern Metal Market

New York, March 7.

All the metals have been quiet in the past week, but prices are well-maintained. The copper trade is awaiting buying for the last half.

Producers of zinc believe that the price of the metal should be higher, or that the cost of the ore should be lower.

The A. S. & R. Co. advanced its New York quotation, March 2, to 9c., but independents already had been selling in excess of this figure.

Traders in tin are becoming nervous over the possibility of deliveries from abroad being interrupted, and 54c. per lb. has been done.

Spot antimony is easier around 30c., duty paid, meanwhile shipments are coming across the country slowly.

Steel plates and pig iron hold the center of the stage. The latter is advancing by leaps and bounds. Eastern Pennsylvania No. 2X is held at $34.50 to $36, furnace. The range of Southern iron has been as much as $7. There is a general belief that the Government soon will be an active purchaser. The British Government has announced that it will terminate many shell contracts March 31, and one shell contractor already has laid off 1800 employees. The plate market is boiling. Eastern Pennsylvania makers ask 5.50c., Pittsburg base, for ordinary tank-plates, and 7c., mill, for ship-plates. The latter are sought for delivery in half a dozen foreign countries. Wire and wire products, and other products have been advanced. The Steel Corporation has withdrawn quotations on plates, shapes, and bars, preliminary to a probable advance in those articles.

The February production of pig iron amounted to 2,637,042 tons or a daily production of 94,180 tons, the lowest since August, 1915, the falling off being a result of the shortage of coke. The February output compares with 101,643 tons per day in January. Three more furnaces were in blast March 1—315 in all—than on February 1, but they were producing iron at the rate of 96,874 tons a day against 101,866 tons daily on February 1. Many furnaces have been banked intermittently.

COPPER

The market continues quiet, and in a general way has undergone but little change since a week ago. Reports have been persistent that heavy buying for the third quarter had been closed, but this is not true. For some weeks, quiet negotiations have been under way and these will eventually result in large export business. The large buyers, both domestic and foreign, are proceeding cautiously, and it is questionable if they will place business in any great volume at present prices. So far as the producers are concerned, their prices for deliveries prior to July are practically nominal. Both Lake and electrolytic for spot delivery are quoted at 36.25 to 36.50c., and these prices are asked for March, also. April ranges from 35 to 36c.; second quarter, 34 to 35c., and third quarter 31.50 to 32c. A little business has been done here and there, at or below the prices mentioned. Munitions work is on the wane in this country, as one result of which the Baldwin Locomotive Works, Philadelphia, Pennsylvania, recently laid off 1800 employees who had been engaged on such work. Great Britain has notified several manufacturers that she intends to terminate shell contracts on March 31, this being verified by a large Eastern steel and ordnance company. Despite this, a factor in the trade stated yesterday that some large brass business was expected to materialize in the near future. The February exports totaled 24,937 tons, about 90% of which was shipped from New York. It is estimated by an authority that since December 1, 1916, probably 30,000 tons has been lost through submarine operations. The London quotation for spot electrolytic yesterday was £151—unchanged from a week previous. *Copper Gossip*, the house organ of the National Brass & Copper Tube Co., a large consumer of the metal, states that the market "appears to rest on a really sound foundation," also that "conditions in this country and abroad warrant expectations of enormous consumption for years to come." It does not, however, believe that any shortage should exist under expected conditions and says that "values should be kept on a reasonable basis with the elaborate extensions completed for a maximum production."

ZINC

Producers and their representatives continue to be dissatisfied with the course of the market. They say that either zinc should be higher or that ore should be lower. They have plenty of orders on their books to keep them busy making deliveries, but they would like to be booking new business if prices were more attractive. March delivery was quoted yesterday at 10.62½ to 10.75c., St. Louis, the New York price ranging from 10.87½ to 11c. April is quoted at 10.25 to 10.37½c., and second quarter at 10 to 10.12½c., all St. Louis. Demand has been spasmodic, especially for prime Western, the brass mills having taken some special. At the same time, business in the latter has not been good, evidence of which lies in the fact that it is offered at premiums of only ¼ to ⅜c. over prime Western. That zinc is a good buy at present levels is indicated to some minds by the fact that dealers have been active buyers, although, on the other hand, they may be attempting to get the market going. The February exports were large, amounting to 11,030 tons. As compared with a week ago, the London quotation for spot was unchanged yesterday at £47. The quotation for sheet zinc is unchanged at 21c., f.o.b. mill, carload lots, 8% off for cash.

LEAD

The market has been quiet to the point of dullness, despite the fact that Western shipments are now coming through a little more freely. An interesting announcement of last Friday (March 2), was that of the A. S. & R. Co. advancing its quotation $10 per ton and making the price per lb. 9c., New York. It must be remembered, however, that the leading producer sells the bulk of its lead on a monthly average basis, and that the independents already were asking far in excess of 9c. So the announcement had little effect on the market except perhaps to brace up consumers who were doubtful as to the strength of the metal. Spot lead is quoted at 10.50 to 11c., New York, with March ranging from 9.50 to 9.75c., at both New York and St. Louis. Very little business is being done in futures, and not a great deal in nearby metal. April is about 9.25 to 9.50c., St. Louis; and May, 9 to 9.25c., St. Louis. The February exports amounted to only 430 tons. The London quotation for spot, as compared with a week previous, was unchanged yesterday at £30 10s.

ANTIMONY

The spot market has been quiet, and prices are a little easier at 30 to 31c. per lb., duty paid, for Chinese and Japanese grades. Some interest has been shown in futures, mostly by dealers. March shipment from Japan is reported to have been sold yesterday at 14.75c., c.i.f., New York. Shipments from the Coast are still very backward.

ALUMINUM

No. 1 Virgin aluminum, 98 to 99% pure is a little stronger at 58 to 60c. per pound.

TUNGSTEN

There is practically no change in the market.

Mining Decisions

Oil and Gas Lease—Construction

Oil and gas lease on nineteen quarter sections held to require sinking of a well on each quarter section.

Producer's Oil Co. *v.* Snyder (Texas), 190 Southwestern, 514. November 25, 1916.

Prescriptive Title—Status of Mineral Rights

Under the law of Kentucky, where a person holding land by occupancy sells the mineral rights to another, the title of the vendee and right of possession of the minerals depends entirely upon the title of the surface occupant. If that title ripens into a good prescriptive title, it inures to the benefit of the purchaser of the mineral rights; if the surface occupant is ejected or abandons his possession before he obtains a prescriptive title, the mineral purchaser loses all his rights also.

Tennis Coal Co. *v.* Sackett (Kentucky), 190 Southwestern, 130. December 15, 1916.

"Grubstake" Agreement—Limitation On

Under a grub-stake agreement with plaintiff, a defendant made a trip to Chicago to interest capital and thence to a certain district in Sonora, Mexico, where he prospected without success. Later he made another trip to Sonora and discovered valuable mines in another district of that State. Plaintiff sued for an accounting on the theory that the defendant was a mining partner during this second trip. Held, that the grub-stake agreement related only to the first trip; that no valuable mines were discovered on that trip; and that plaintiff had no interest in the results of defendant's second trip, made at a later date to a different district.

Hollingsworth *v.* Tufts (Colorado), 162 Pacific, 155.

Oil Lease—Rights of First Lessee

In a suit by a lessee of oil land to enjoin operations by the assignee of a subsequent lease, it was shown that the lessor in granting the second lease, inserted therein a clause reciting the existence of the former lease and requiring the second lessee to defend any suit thereon. Held, that this was sufficient notice to an assignee of the second lease of the rights of the first lessee, and that the mere fact that the first lessee delayed action for sixteen months and until the assignee of the second lease had expended considerable money in developing the property, would not be available as a defense to the latter party.

Mexico-Wyoming Petroleum Co. *v.* Valentine (Wyoming), 237 Federal, 539. October 30, 1916.

Annual Labor—Time for Performance

Plaintiff went upon his mining claims on the last day of the year in which assessment work had to be done and commenced work on each of two groups of claims; no work was done on January first, but on January second and throughout the winter, plaintiff continued in possession, working and developing his claims upon which considerable work had been previously done. On the first of January defendants went on the ground and, finding no one in possession, proceeded to re-locate the same as forfeited ground. Held, on suit by plaintiff, after reviewing authorities, that his entry and commencement of labor on the last day of the year, followed by continuous possession and work with only brief interruptions during the ensuing year was a sufficient compliance with the law requiring performance of annual labor, and that plaintiff's rights were established.

Plough *v.* Nelson (Utah), 16 Pacific, 1134. December 4, 1916.

Book Reviews

Elements of Mineralogy, Crystallography, and Blowpipe Analysis. By A. J. Moses and C. L. Parsons. Pp. 631. Ill., index. D. Van Nostrand Co., New York, 1916. For sale by Mining and Scientific Press. Price, $3.

This is the fifth edition, enlarged (200 pages more) and extensively re-written. The practical standpoint of former editions is maintained, this including a description of all common or useful minerals, their composition and occurrence, the tests necessary for their identification, the recognition and measurement of their crystal angles, and their economic importance and uses in the arts. Crystallography occupies Part I of ten chapters, of 155 pages, and clearly expounds this generally complex subject. The 52 pages on blowpipe-determinations will be found of practical value, especially those on the rarer minerals that are being sought more and more. The remainder of the book is devoted to mineralogy, detailing the physical and chemical characteristics of minerals, both common and rare. Tables give the methods for a rapid determination of the common minerals. Generally speaking, we like the arrangement followed, and find the methods up-to-date.

Engineering Analysis of a Mining Share. By J. C. Pickering. McGraw-Hill Book Co., New York, 1917. Pp. 92. 12mo. For sale by Mining and Scientific Press. Price, $1.50.

This is an interesting and a useful book. It would have been better if it had been edited carefully and if a wider reference had been made to other writings on the subject; but that is a good deal to ask in these days of hurried book-making. The references to exploration companies would have been more convincing if the names had been given. However, after making these minor criticisms, the reviewer is glad to commend the book as a serious and intelligent effort to analyze a recurrent problem and to explain it in a perspicuous way. The various risks involved in mining, the fundamentals of a report, the inevitably deceptive discrepancies between operating profit and real profit, and the valuing of a mine, are discussed in turn. Some of Inwood's tables are reproduced conveniently. The last chapter contains analyses of a number of important mining enterprises, and the author closes by stating that the Utah Copper is the nearest approach to a mining 'investment.' His style is pleasant, his judgment appears sound, and his whole treatment of the subject is well worthy of an experienced engineer.—T. A. R.

Recent Publications

Statistics of United States, Railways, 1905-1915. P. 57. Bureau of Railway Economics, Washington, D. C., 1916.

Report of the Governor of Alaska to the Secretary of the Interior for the year ended June 30, 1916. P. 109. Map.

Refining and Utilization of Georgia Kaolins. By Ira E. Sproat. Pp. 59. Ill. U. S. Bureau of Mines, Washington, 1916.

Sugar Pine. By L. T. Larsen and T. D. Woodbury. Bulletin 426. P. 40. Illustrated. U. S. Department of Agriculture, Washington, D. C., 1916.

Review of the Geology of Texas. By J. A. Udden, C. L. Baker, and Emil Böse. Bulletin 44. P. 164. Ill., maps, index. University of Texas, Austin, 1916.

The Geology of Kingston and Vicinity. By M. B. Baker, with appendix, I. The Ordovician Limestones of the Kingston Area. By E. M. Kindle. Appendix, II. Synopsis of the Common Fossils of the Kingston Area. By A. E. Wilson and K. F. Mather. Twenty-fifth annual report of the Ontario Bureau of Mines. Pp. 70. Toronto, Canada, 1916.

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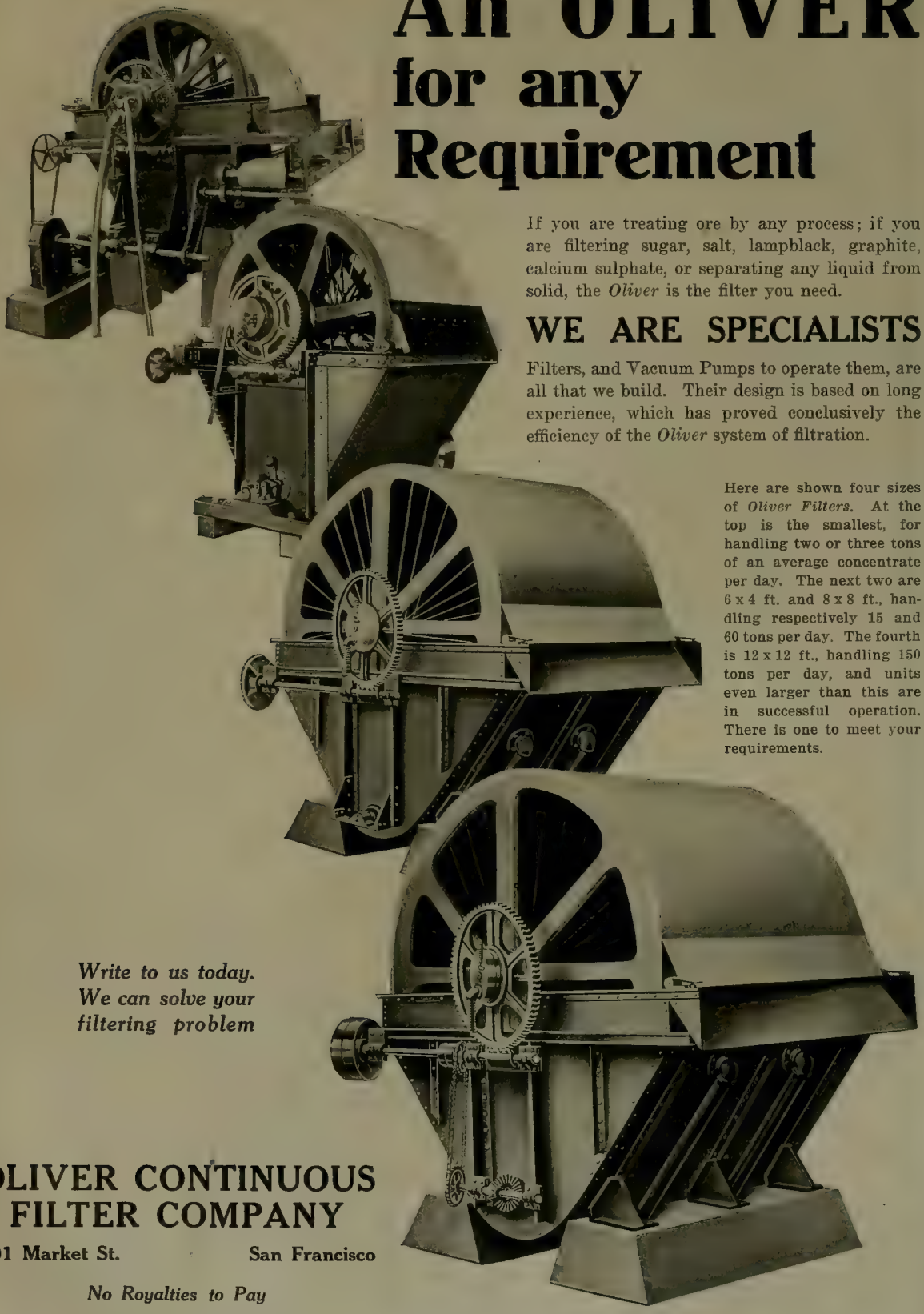

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EDITORIAL

T. A. RICKARD, Editor

OUR contemporary *The Canadian Mining Journal* adorns its current issue with the best picture of a specimen of gold-bearing quartz that we ever remember to have seen. It is handsome and cheerful.

GOLD production in 1916 was about $10,000,000 less than it was in 1915, according to *The Mining Magazine*. We shall discuss the subject when all the available statistics are at hand. Those from Canada have just been published, showing that 926,963 ounces of gold worth $19,162,025 was produced in 1916, as compared with 918,056 ounces worth $18,977,901 in 1915.

CURVES representing the cost of living threaten to run off the diagram, as we note from our reading of *The Annalist*. The curve is now sharper than that recording the increase in the gold held by the Federal Reserve Banks. The Index Number, representing the average price of 25 food-commodities, is now 233 as contrasted with 161 a year ago, and with an average of 80 in 1896.

WE publish an article on metallurgical practice at Treadwell by Mr. S. B. Combest, foreman of the cyanide plant. This will be appreciated by members of the profession as an authoritative and detailed account of the technical operations in the mills on Douglas Island now operated by the consolidated group of Alaska-Treadwell companies. Such painstaking and clear descriptions of current practice are most useful, having a value that is both timely and historical.

AMONG recent appeals to the gullibility of the public, we note the circular of the National Gold & Silver Mining Co., of Chicago, which urges the stockholders to seize "the greatest opportunity of a lifetime" in subscribing money for sinking a new shaft on their property. Funds are being raised for this purpose through the sale of more shares to these stockholders. The President of the company asserts: "The rule in mining is, that with normal volume you will get normal profits. That as you increase your volume, your profits will increase according to the square of your volume. That is, you double your normal volume, then your profits should be four times your normal profits. If you treble your volume your profits should be nine times your normal profits. The company figures that sinking the new National shaft will increase the volume of its present capacity from five to ten times. Square this increase and you can readily see that our profits will increase at least twenty-five times those of our present capacity." This is only one more example of confusing 'rock' with 'ore'—a basic blunder. The digging of a hole in the ground, whether it be large enough to give sepulture to a dead mule or to swallow a cathedral, does not make a mine. The purpose of mining is to make money, not to hoist rock. Volume, whether normal or abnormal, bears no relation to total profit unless the unit of volume connotes a unit of profit. Judging from the character of this appeal, we infer that the mine is not making money and that the result of hoisting 25 times more rock will be an approximately equal multiplication of loss.

LAST week we stated that the American Metal Company had not exercised its option upon the excess tonnage of zinc concentrate from the Butte & Superior mill, and that the American Zinc, Lead & Smelting Company had arranged to absorb 100,000 tons of this concentrate annually. Eastern market-papers about the same time were announcing that the entire product of the Butte & Superior had been taken by the American Metal Company. Neither statement was exactly true. The American Metal at one time purchased a large tonnage, but it curtailed the amount on the outbreak of war. This company has now reverted to the earlier arrangement, but the Butte & Superior continues to smelt the larger part of its surplus tonnage at the plants of the American Zinc, Lead & Smelting Company at Caney and Dearing, in Kansas, and is at the same time selling a portion in the open market.

CONFISCATION finds sanction in law as well as in might under Carranza's régime. That is the sanctification of banditry. Manifestly the intent of the First Chief and his followers is to fatten on the re-distribution of valuable mines, with special ogling in the direction of the oilfields. This appears from the re-classification of non-metallic deposits, placing them under the jurisdiction of the Department of Fomento subject to the general mining law. Thus does Carranza exemplify the Spanish proverb of keeping one eye on the devil and the other on San Dimas. Late dispatches announce that Ambassador Fletcher has secured a promise from the Minister for Foreign Affairs that the Mexican government will not put on the screws precisely in the manner and at the time prescribed by the so-called tricolor circular No. 31, officially issued, to the consternation of mine-operators, on March 1, and dated February 21. The 'white group' comprises those who have paid their taxes and have continued operating; the 'blues' are those who have requested an extension of time for compliance with the arbitrary decree of September 14 last. Those who

see 'red' are the unfortunates that took no notice of the impossible decree of the Mexican chief. The Secretary of Fomento has accordingly turned over the list of delinquents to the Secretary of Hacienda, or Finance, as we would say, for the purpose of confiscation. It is hinted in the circular that forfeiture may possibly be averted by submitting reasons for non-fulfilment, declaring intention to resume work, and demonstrating the necessary financial ability. If the Secretary of Hacienda should then deem the reasons given and the security offered adequate in any special case, he will submit the proposals to the First Chief for consideration and recommendation. Apparently our Ambassador has received assurances based on this flimsy pretense of justice. Whatever the question of justice or privilege, it always comes back to the First Chief. He is the source of whatever dispensation from tyranny anyone may hope to receive. Rights there are none; it is an administration under which life and property are dependent on executive sufferance.

NAVAJO MINES CORPORATION is the impressive title of a new company owning sundry locations in the north-east corner of Yuma county, Arizona. The promoters of this enterprise are advertising the sale of stock as a bargain for those desirous of becoming rich easily and quickly. One of the advertisements describes the discovery of the ore by an 'old-timer,' who found a big boulder containing copper, besides "some very rich spots in gold and silver." This prospector could not ascertain the source of this big piece of 'float,' so he went up the hill, where no signs of ore were visible—"simply country-rock." This did not discourage him, however, for "he went back to the powder-house and obtained some sticks of dynamite and put in some pop-shots at regular intervals" and at once "opened up a big vein of high-grade ore, covered with only five feet of country-rock and dirt." We are told that he used only half a stick of dynamite in his pop-shooting, so that the marvel extends even to the effectiveness of the explosion; but what we want to know is how he sensed the spot for this useful performance.

Nationality in Mine-Accidents

Discrimination between immigrant and domestic labor in a Government report would savor of invidious comparison at least, the U. S. Bureau of Mines in its recent so-called technical paper entitled 'Metal-Mine Accidents,' by Mr. Albert H. Fay, makes no such distinction. At the Miami mine, however, record is kept of the nationality of the workmen involved in mishaps. The caving method is there used, which method is not, as frequently stated, excessively dangerous. According to the Bureau of Mines statistics the largest number of accidents in proportion to the number of men engaged was in overhead stoping with the aid of stulls, where the ratio of accidents was 0.51 to each miner employed. In the caving method the ratio for the entire country was 0.31 per miner. The Miami record reflects credit upon the management, since the ratio there was only 0.22 per worker. Difference in statement and detail makes a full comparison with the national figures impossible. At Miami the ratio of the total men employed during the year to the average number working at one time was 3.8, applying which we deduce that the general accident-ratio per man was 0.86. The force at Miami is strikingly cosmopolitan, 29 nationalities being represented. In the order of relative numbers Austrians come first, comprising 30.4% of the force, followed by Spaniards 16.3%, Americans 13.4%, Mexicans 13.2%, English 8.6%, thence decreasing to a stray Norwegian and Brazilian. Calculating the accident-ratio per man, dividing the number of accidents by the corresponding average number of men of each nationality working at one time, the predominant Austrian shows up unfavorably with a ratio of 0.95 compared with the evidently careful Englishman ranking nearest to immunity with a ratio of only 0.27. Regularity of attendance also speaks well for the English miner, the ratio of total number employed throughout the year to the average attendance being 1.7 in his case, against 3.1 for the Austrian. The Mexican suffered the greatest number of accidents, the ratio per man being 1.47, while his unsteadiness as a laborer is shown by an attendance ratio of 5.7. Next to the Mexican came the German with an accident ratio of 1.25, closely followed by the Italian with 1.23 per man. The American miner stands second on the list as a safe worker, the accidents per man being 0.53, but his wandering habit is revealed by the attendance ratio of 4.1. It is interesting to note that the Spaniard, second in numbers to the Austrian contingent, reveals an accident-ratio of 0.88, and in the matter of attendance he has the relatively good average of 3.8, surpassing in this respect the Americans, Mexicans, Italians, and Germans. The statistics given do not include the nature of the accident. A just comparison of relative efficiency should take into account the character of work performed. Nevertheless, the rather close correspondence between the number of accidents and the constancy of the miner in his attendance is extremely significant. The sense of responsibility is related to carefulness in the performance of duty; the steady worker is also the safe worker. This revelation, however, of the tremendous proportion of men engaged in mining who receive injuries will startle the thoughtful reader. The accident-ratio in all classes of metal mining for the United States in 1915 was 0.36 per man employed. At Miami, where race enters as a factor, the averages are not out of consonance with the general rule throughout the country. This is natural, since the mines of America are manned chiefly with foreign labor. The ratio of number of days' disability to number of workmen would plot practically a parallel curve with the accident-ratio. The Austrian had an average of 11.5 days incapacity from accident per man engaged; the Mexican 18.7, the German 16.9, the Italian 14.4, the American 6.2, and the Englishman 3.9. Racial characteristics seem to govern. It would be interesting to make efficiency comparisons as well.

The History of Flotation

The story of the flotation process is not that of a flowing stream of events, nor is it one that can be traced from a single source. Even an account necessarily as brief as the one we conclude in this issue will indicate to the reader that many cross-currents, not to say ugly snags, break the smooth surface of the record. Who, except a party to the patent vendetta, would be willing to name the first discoverer of the principle underlying flotation or the final inventor of a workable process? Was Haynes's use of oil or Bradford's surface-tension effect the pioneer invention? Neither, we think; for neither led to fruitful use. Was Carrie Everson the real forerunner? We think not, because her efforts threw ridicule on the flotation idea instead of stimulating properly qualified persons to further research. Was it Sulman? Assuredly, if any one man may be given credit, he should be chosen as the champion exponent of flotation, because he has been a student of surface-tension and allied physical phenomena longer than anybody else, and he has personally contributed to many of the important steps in the art. But a venerable voice is heard; Samuel Crowder reads a letter he wrote twenty years ago, in which he suggested using 1% or less of oil for the concentration of chalcopyrite from a quartzose ore. That letter was written to Elmore, who had devised an oil-flotation process as a sequel to the purchase of the Welsh gold mine at which Robson, four years earlier, had experimented with a similar process in collaboration with Crowder, who bought the mine from Elmore's father. Thereafter the Elmore brothers exploited their method with a success to be measured not so much by metallurgic operations as by the publicity that they gave for a decade to the new principle of concentration. They kept the flag flying, while Sulman and his partner were trying to evolve something practicable out of Cattermole's messy method of granulation. These claim to have discovered froth-flotation while following this path of research, but the statement is not convincing, even if made in good faith, because in the interval they had learned how Froment used a gas to make bubbles and they had also discovered that Froment's patent was already too old to allow of duplication in the United States. Besides Froment, the Australian metallurgists, Potter and Delprat, had learned the metallurgic value of bubbles and the making of froth was well under way. We are told that suddenly, out of a clear sky, in March 1905, the spectacle of the wondrous froth of patent 835,120 was vouchsafed to the group that had banded themselves together under the name of Minerals Separation. Then the trouble began! No, not precisely then; the miraculous discovery was not made known to the American public or applied to American ore-dressing practice until six years later and was not a demonstrable success for two years more. Then came the struggle not only to obtain a monopoly in the use of a new branch of metallurgy but the much more objectionable effort to place an embargo on technical information concerning it, backed by a malapert attempt to tie the profession to secrecy. All this is too recent to need further recapitulation, for has it not been recorded in the pages of the MINING AND SCIENTIFIC PRESS? There remains only to make a suggestion, based on a careful reading of the voluminous records of the successive litigations, particularly the so-called demonstrations of various processes before perplexed judges, that no one man and no single group of men 'invented' or 'discovered' flotation, but that it is the cumulative result of empiricism in the mill and laboratory, rather than of patent disclosures; it is the slow product of manipulative skill on the part of a number of men most of whose names are not recorded and never will be recorded. Given the idea of pulp, oil, and mixing in the presence of air, a froth was bound to ensue that would buoy the mineral particles to the surface and so separate them from the barren particles of gangue.

Meanwhile, the forecast made in these columns more than a year ago that the function of oil had been exaggerated and that other contaminants or modifying agents would be found suitable for decreasing the surficial tension of water, and so prolonging the life of the bubbles constituting the froth, is coming true. In the Britannia mill, treating a chalcopyritic ore, less than half a pound of oil per ton of ore is being used in the flotation-cell, while at Broken Hill the use of soda-cake, instead of oil, has proved successful. As for that so-called 'critical' proportion, evolved out of the inner consciousness of patentees and their attorneys, and accepted as a scientific dictum by a misguided court of law, it has been rendered absurd within a month of the Supreme Court's solemn decision endorsing the fallacy, by the fact that large mills, each treating over 1000 tons per day, are getting good metallurgic results with 20 to 23 pounds of oil per ton of ore, a proportion that was previously assumed to kill the effective operation of the flotation machine. We are only at the beginning of flotation. The process is as much bigger metallurgically than cyanidation as cyanidation was more far-reaching than chlorination.

State Smelting

Socialization is finding a new expression. Proposals for the creation of State smelters have been made both in Colorado and Arizona. This demand is a direct outgrowth of the abnormal trade conditions produced by the War. Shipments of ore have multiplied enormously; it has been a golden era for the small producer; prospectors by the hundred all over the United States have been able to take out ore and not infrequently to make modest fortunes in the operation of mines that would possess no chance of being persistently worked with metals at usual prices. Equally have the large mines been stimulated to extraordinary production at this period when a single ton of ore is worth as much as two or three tons in ordinary times. Under such circumstances it is natural that the custom smelters should be overwhelmed. To accept and pay for all the ore that

might be flung at them, without imposing some restriction would soon empty their treasuries. Even if they could provide the capital to carry such large stocks of metal until finally sold in the Eastern market, the purchase of huge tonnages on war-inflated quotations would entail an element of risk that no intelligent body of business-men could be expected to take. We are not undertaking to argue a case for the smelters against their critics, nor to whitewash any grimy reputations. We appreciate the natural desire of the miner to take advantage of prices such as have never been seen before nor are likely to be seen again. It is proper and right that he should break into this brilliant market if he can, but the evident difficulties of the situation must be faced. In a large sense the custom smelters, by the very magnitude of their operations, and by virtue of the necessary functions they perform in our complex economic system, become in effect public servants. As such their responsibility to the people might lay them open to legislation with the give and take of special privilege and specific obligation looking to co-operation for the general welfare, on the same theory as common carriers. This might be more equitable than to confront them with a system of State-controlled competition granting that it could be made effective.

The smelters certainly should not be blamed for protecting themselves against an unsaleable accumulation of metals. The interest on the capital locked up in excessive stocks would soon absorb more than their legitimate smelting profit, or else they would be compelled to sell in quantities that would depress the market and precipitate financial disaster. This aspect of the business is so plain that no one can fail to see the motives that have led to restrictions upon the avalanche of ore that has been offered, and to the practice of discounting current quotations in effecting settlements. The position of the small shipper is equally understandable when he calls for an open market and full pay for his output. It would be most desirable to accomplish it if possible, but it is not conceivable that State-owned and operated smelters could afford the relief expected. The cost of a modern well-equipped plant capable of competing with the old established operators would prove a heavy burden; the capital necessary to carry the stocks of metal until they could be sold to advantage would amount to still greater sums. The risks due to changing market conditions would almost immediately force the adoption of measures, similar to those now employed by private smelters, in order to safeguard the State treasury. Thus the State would find itself in the end compelled to deal with the great metal-selling organizations in order to get rid of its output. There is no escape from these controlling influences. Normal competition among the great interests is what rules, whether the State or a private corporation reduces the metal from the ore. No State could finance the horde of small producers clamoring for an outlet to market. It would be compelled, sooner or later, to throw the burden back upon the shippers. If it should undertake to make settlement by the issuance of warehouse certificates the miner would again confront the difficulties of the dominating agencies at the great market-centres. He would be under the necessity of negotiating his certificates at a discount, in the computation of which the identical factors that the private smelters are obliged to take into consideration in their dealings with individual producers would re-appear. It is well-known that small independent custom smelters invariably suffer failure. Only where the smelter has a sufficient supply of ore available from mines under its control, so as to possess a basis for operating apart from the occasional offerings of custom ore, has success been attainable. Even with these advantages the obstacle of discriminative freight-rates has always to be met, and this is hard to overcome. Within the borders of the State the rates might be subject to control, nevertheless an equitable adjustment of intra-State tariffs would not solve the whole problem; the rates on matte and bullion to seaboard markets would remain a stumbling-block, unless the independent smelter were erected at a point where large rival interests were already established, in which case the existing published rates would automatically apply. The Bunker Hill & Sullivan is a good illustration of the difficulties presented by discriminative freights. The rates on lead bullion from the East Helena smelter, of the American Smelting & Refining Company, are $10.15 per ton to Atlantic ports and $4.50 to Pacific terminals, equivalent to a coast-to-coast rate of $14.65. The Bunker Hill & Sullivan was offered a transcontinental rate of $18, applying to its smelter at Kellogg, Idaho. This has since been modified, but competitive figures so far have not been obtainable. Before proceeding toward the provision of State institutions as a remedy for private monopoly in smelting, the risks and the magnitude of the burden upon taxpayers must be recognized unflinchingly. It must be considered, also, that erratic and uncertain supplies of ore from a multitude of sources greatly increase the difficulty of maintaining effective smelting mixtures. Keeping a proper balance between base and acid becomes burdensome and costly when no large dependable resources of ore having a uniform composition are available. The operation of a custom smelter relying on a heterogeneous collection of small shipments must necessarily prove expensive, so that it would be impossible to offer rates attractive to those having important quantities of ore to offer. The inevitable graft and inefficiency that creep into large business controlled by political influences shout another warning. It is possible that small shippers might find the way to market easier by forming associations analogous to those that have been found helpful in marketing agricultural products. Through a single co-operative agency contracts could then be made for the delivery of important quantities of ore of known average composition. This would relieve the smelter from the annoyance of dealing with a multitude of individuals, and the dependability of such collective resources would make them attractive and worthy of consideration on more favorable terms.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Catching Floating Metallic Films

The Editor:

Sir—The discussion in a recent issue of your paper, as to the inventor or discoverer of the flotation process, brings out the fact that the process became known through the efforts of mill-men to save the metal escaping in the form of fine filmy particles floating on the water.

Every mill-man is familiar with this condition and the difficulty of arresting this loss. A few years ago I made some experiments toward saving this 'float' metal, which so far as I know have never been put into use by any one else.

Our ore was first amalgamated, then went over the tables. In the concentrate-troughs we used to notice fine lacey metal floating in considerable quantity. It was evident that the loss from this source amounted to a good deal daily. I prepared a tank with a capacity of a ton of water; bored a hole at one end of the concentrate-troughs about two inches from the top and allowed the surface-water from the troughs to pass slowly through a galvanized iron gutter into the tank. Samples were carefully taken every few minutes at the point where the water left the gutter.

It is generally known that water filtered through granulated charcoal is about as pure drinking water as one can get. I had three tubs made, about 18 in. in diameter and 12 in. high, and placed the three tubs one over another. About an inch from the bottom of the upper tub was a 6-mesh screen. The second tub had a 10-mesh screen and the third, or bottom tub, a 20-mesh screen. On the screens was a layer of granulated charcoal. The three tubs (or screens) were placed over a bucket for catching the water as it percolated through the tubs. The water was allowed to pass slowly out of the tank into the top tub, down through the other two tubs into the bucket. *When the water entered the bucket it was pure enough to drink.* The charcoal invariably carried fully 99% of the valuable metal in the water, and on three or four occasions it assayed precisely what the water did before going into the tubs, and I have seldom found more than a trace of gold with the water in the bucket.

I wish to make it clear that these experiments have always been conducted on a small scale. At the same time the results have been so uniform that I believe they would be the same on a large scale with the right kind of apparatus and the charcoal properly prepared. There are no difficulties in the way of recovering the values from the charcoal and the extra cost of the operation is almost negligible, as the same charcoal can be used for a considerable period of time.

GEORGE F. GOERNER.

El Paso, March 7.

The Propeller-Agitator

The Editor:

Sir—In your issue of March 3, Roscoe Wheeler, of Hedley, B. C., describes with illustrations the propeller-agitator and calls attention to your reference to the device in your article on the Nickel Plate mill. Naturally, the reader would think this ingenious pulp-stirrer something entirely new in metallurgy, but I find the following description of this propeller-agitator, baffle-board and all in the issue of the MINING AND SCIENTIFIC PRESS of September 17, 1904, page 188, where it appears under 'Concentrates:'

"There are various devices for agitating pulp in the cyanide process. In some instances compressed air is employed, and has been found to be an efficient agent for this purpose. A device which has been successfully used for the agitation of sulphides in cyanide-tanks is a screw-propeller having two blades. This is keyed to a vertical shaft secured to timbers and set directly over the centre of the tank. The shaft is suspended by a collar keyed near the upper end, and held in position by passing through a box bolted to a timber about the middle of the shaft. This lower box acts like the lower guide of a stamp-stem. A pulley is fixed to the shaft either at its upper end, or between the upper and lower guides, and the agitator revolved by means of a driving belt, or it may be actuated by means of a gear, though the former is preferable. The propeller is fixed just above the surface of the pulp—silicious sands or sulphides—whatever it may be, and is submerged by the solution. When the propeller is revolved it quickly causes the pulp to be taken up and held suspended in the solution. It has been found that the rotary motion thus imparted to the pulp has a tendency to cause it to bank up around the inside periphery of the tank. This has been obviated by placing a plank on edge beneath the propeller, and extending entirely across the tank. The result is a perfect agitation with no large accumulation of pulp at any one place. In the case of sulphide treatment, the pulp being very heavy settles and packs hard almost immediately upon the stoppage of the screw, but upon re-starting it the pulp is again quickly taken into suspension. As in

the case of agitation by air, the continuous revolution of the screw is not deemed necessary. The power required is small, and the cost of the equipment not excessive. It may be run at any number of revolutions found to accomplish the desired result."

This reference to the propeller-agitator was printed 12½ years ago, and at that time evidently was not new. I do not know the date of Mr. Devereux's patent.

AN OLD SUBSCRIBER.

San Francisco, March 3.

Misfires

The Editor:

Sir—I have read with interest the articles on the subject of misfires appearing in your publication, and will state that I have gathered hints from experiences on this score, which I may offer in discussion.

Should a charge of explosive 'misfire' the fault can lie with but four things, the fuse, the cap, the explosive, or the method of combining these to bring about the effect of blasting.

Fuse, if properly handled and not impaired by age and storage, generally burns from end to end. Few instances have been found where a defect in the powder train caused the fire thereof to go out. Detonating-caps have the twofold office of force and heat. The theory of blasting-caps is based upon the energetic explosive action of fulminate of mercury, and the force and heat are projecteed forward from the muzzle end of the cap. When the cap is properly crimped on the fuse, the latter serves as a plug to the muzzle end of the cap, and in view of the theory of the detonating-force of the cap the rightful and proper place for it is in the primer cartridge of dynamite at the end of said primer cartridge, that end to be placed nearest to the collar of the hole, the cap set in the outer end of the primer cartridge, parallel with its longest axis. The cap should be set in the primer cartridge about three-quarters of an inch below the muzzle end of the cap. If the dynamite used as a primer should happen to be old, it is best to cut the paper around the cartridge and break the cartridge in two, seating the cap in what was the central part of the cartridge, thus giving a chance for the initial detonation to start in an unimpaired portion.

Before inserting the fuse in the cap it should always be freshly cut, and it is good practice to cut off a half inch lest some portion of the powder-train in the fuse may have become affected through previous handling or contact with moisture. The cap should be crimped to the fuse with a crimper, making a broad crimp, not with a dull knife or the teeth. If a proper crimper is used, the joint will be watertight without waterproofing with axle-grease, tallow, white lead, soap, or other material. The fuse should be tied securely to the primer cartridge with a strong twine. It is not necessary for the fuse to be bent at an angle that will break its walls, rendering it liable by breakage to get the powder-train of the fuse damp through such break as a sharp bend will make. It is not advisable that the fuse should burn past any part of the charge of explosive. The danger from the fuse burning past part of the charge of dynamite lies in the fact that the 'side spit' of the fuse often ignites it prematurely, when it will burn with great rapidity.

The method of lacing the fuse through the primer cartridge, and placing the cap in a slanting position therein is without justification, and is opposed to every consideration of safety and good practice. The lacing of fuse through the dynamite leads every now and then to a burned charge. The placing of the cap in a slanting position in the primer cartridge of dynamite, when it is understood that the force of the cap is exercised in a direction opposite to the muzzle, results in part of the force being directed against the side of the drill hole. The strongest caps are worth their cost as against weaker caps only when the full strength of the cap is realized; it is not advisable therefore to waste the strength of the cap by placing it in the charge so that a secondary or reflex action from the walls of the hole is produced, and that is what a slanting position of the cap in a primer brings to pass.

To aid further in safety against misfires, after the drill-hole is charged, place on top of the primer-charge a wad of paper, press down firmly with a tamping-stick, then tamp the hole firmly with clay or other material to the collar. If, then, a misfire does occur, the paper will establish a point so that the miner in digging out the tamping will know when he is close to the explosive and will proceed with due caution.

There is a current notion that if the initial detonation takes place in the middle or at the bottom of the drill-hole, the charge 'pulls' better than if the detonation commences at the end nearest the collar of the hole. There is nothing known to the manufacturers of explosives or detonators that supports this idea, and all tests indicate that the breaking efficiency of the holes so loaded that the primer is nearest the collar of the hole, will give the best results. Some may object to the trouble required with this method of charging drill-holes, but no pains are too great if it makes the life of the miner more secure, and 'safety first' should rule. The practice outlined above will reduce 90% of misfires, 'stinkers,' and deficient breakage of material blasted. It is to be remembered that this letter describes the methods that the manufacturers of fuse, caps, and explosives understand as the way in which their products should be used.

T. T. EDWARDS.

Seattle, March 3.

THE tungsten exportation from Burma in 1916, according to a United States consular circular, was 3806 tons, all of which was wolframite. The output for 1915 was 2661 tons.

A NEW COAL-FIELD has been discovered east of Harbin, in the Huton Shan mountains of China. This bed of coal is reported to be 233 ft. thick.

The History of Flotation—II

By T. A. Rickard

Froment

The scene shifts from Australia to Italy. At the time when Potter and Delprat introduced their methods at Broken Hill, another investigator was about to contribute his quota to the development of flotation. The Elmore bulk-oil method had been seen by Alcide Froment at the Traversella mine, in Italy, where he was engaged as an engineer in 1901, when he invented what he himself termed "a modification of what is known as the oil process of concentration." His modification—patented in June 1902—was to introduce a gas into the freely flowing oiled pulp used by Elmore. He argued, in his patent, that "if a gas of any kind is liberated in the mass the bubbles of the gas become coated with an envelope of sulphide and thus rise readily to the surface of the liquid where they form a kind of metallic magma." The phrase "gas of any kind" is important, for, although he generated his bubbles of gas by the reaction between sulphuric acid and the carbonates of the gangue or between the acid and the limestone that he added to the pulp, he hit upon one of the fundamental principles of the flotation process as we know it now. If he had specified air as the particular gas to be used he would have been acknowledged as the pioneer of present-day flotation. Air was present, of course, and played an important part in the operation, for in his description he specified the use of a centrifugal mixing device "in which two stirrers work in opposite directions, making 300 revolutions per minute." In his patent he explained that "the sulphide particles when moistened by a fatty substance" have a tendency "to unite as spherules and to float upon the surface of the water." He stated also that "the rapidity of the formation of the spherules and their ascension is in direct ratio to the quantity of gas produced in a given time." As to oil, his patent mentions "a thin layer of ordinary oil," but in the instructions given by him to the Minerals Separation people he specified as little as "1% of oil for ore containing up to 5% of metals" and up to 3½% "for ore containing 50% of metallic lead."

Minerals Separation

Before proceeding further it will be necessary to trace the origin of Minerals Separation, Ltd. At the end of 1901, John Ballot, W. W. Webster, and a Mr. Hay formed themselves into a syndicate to take an option on the Australian rights to the Elmore bulk-oil process. They engaged the firm of Sulman & Picard to act as advisory metallurgists. Acting on their advice, the syndicate did not exercise the option. In December 1902 John Ballot purchased the patents of Arthur R. Cattermole and assigned them to his syndicate, which became known as the Cattermole Ore Concentration Syndicate. On December 31, 1903, this syndicate was succeeded by a company, called Minerals Separation, Ltd., the directors being John Ballot, J. H. Curle, W. W. Webster, S. Gregory, H. L. Sulman, and H. F. K. Picard.

Now we return to Froment. His work appears to have been unknown in England until an abstract of his British patent was published in the Journal of the Society of Chemical Industry and was seen by Mr. Sulman in August 1903. Whereupon negotiations for the purchase of Froment's patent were opened by Mr. Ballot. He went to Milan to meet Froment, who, on November 7, 1903, sold his rights for £225. On December 29 Froment sent some drawings, with descriptions and instructions explaining his mode of operation. Early in 1904 a small plant designed by him was forwarded to London, but the apparatus was discarded, and destroyed subsequently, by the Minerals Separation people. Froment was in poor health at that time, and he died soon afterward. His patents had been taken out in Great Britain and Italy, but not in the United States, and when Mr. Ballot acquired them it was too late to obtain American rights, more than a year having elapsed since the grant of the British patent, on June 9, 1902. So the Froment patent was set aside as of no immediate value.

Cattermole's patents, which had been duplicated in the United States, describe the mixing of emulsified oil with acidulated pulp, which is then agitated so as to agglomerate the metalliferous particles into 'granules' that sink and are readily separated from the lighter gangue by an up-current of water. In his American patent, No. 777,273 of September 28, 1903, Cattermole specified the proportion of oil to be used as "usually an amount of oil varying from 4% to 6% of the weight of metalliferous mineral matter present in the ore."

Much of the early experimental work of Minerals Separation was done in the laboratory of Sulman & Picard, at 44 London Wall, but in March 1904 Mr. Ballot established his own laboratory on Aldermanbury avenue, and it was there that decisive results were obtained. In 1903 a model 50-ton plant, to use the Cattermole process, was constructed and sent to the Central mine at Broken Hill, Australia.

The Minerals Separation people, notably the chief metallurgists, Messrs. Sulman & Picard, were experimenting with Cattermole's method and trying to develop a workable process at the time when their attention was called to Froment's patent. When they acquired this patent, they made experiments in accord with the specifications and the later instructions sent by Froment. To the detached spectator it would seem more

logical to assume that Froment's floating 'spherules' rather than Cattermole's sinking 'granules' would lead to something like the froth-flotation process of today. But that is not the story told in the courts of law. The metallurgists identified with Minerals Separation testify that they had discarded Froment's patent and his instructions, having found them worthless, and were trying various modifications of the Cattermole method when suddenly they happened upon the particular combination essential to the froth-agitation process. Messrs. Ballot, Sulman, and Picard agree in stating that protracted experiments were being conducted in their London laboratory under the immediate charge of Arthur H. Higgins, who had been instructed to try all sorts of variations in temperature, acidulation, oiling, and mixing. Nothing noteworthy happened until the proportion of oil was reduced, whereupon the 'granules' began to rise instead of sinking and "the quantity of floating material increased rapidly when the oil was reduced below a certain point, this certain point being 0.62% of the oleic acid on the ore." So testifies Mr. Ballot. Thus happened "the startling discovery of the agitation-froth process," according to W. H. Ballantyne, Mr. Ballot's patent lawyer. The date was March 3, 1905. Then followed the British patent No. 7803 of April 12, 1905, and the American duplicate, No. 835,120—the date of application being May 29, 1905, and the date of issue November 6, 1905.

Before leaving this part of the story it is worth noting that the Cattermole 50-ton plant, already mentioned, had been erected in the Central mill early in 1904, and experiments were made there under the direction of G. A. Chapman. Tests showed that when using 0.75% of oil on the ore "the results were excellent, with all float concentrate, no granular material being formed." So says James Hebbard, the manager of the Central mine.[11] The adjective "excellent" is used in the light of later events, for floating of the mineral was incompatible with the granulation upon which the Cattermole process depended. The importance of the floating does not seem to have been appreciated until a year later—early in 1905—when "a remarkable development in the operation was discovered (strangely enough, at the same time here [Central mine] and in the Patent Co.'s [Minerals Separation] laboratory in London), which had for its main principle the reversal of all previous operations, and consisted in the complete flotation of each particle of mineral independently in place of granulating the mineral particles and causing them to sink, thus not only revolutionizing the process, but greatly simplifying and cheapening it. The developments noted were mainly along the line of decreased consumption of oleic acid, for example, from 3% oleic on ore, resulting in very little float, down to 1%,[12] giving practically a complete float." According to this, the Higgins 'discovery' was made independently and contemporaneously at Broken Hill, but the underlying principle was detected a year earlier by Mr. Chapman, who had experimented with the Froment process in the London laboratory of Minerals Separation during 1903—again the suggestion that Froment had pointed the way to the agitation-froth process.

Next we revert to the first contact between the Elmore brothers and the Minerals Separation people. As already mentioned, in 1901 the Ore Concentration Syndicate gave Messrs. Ballot, Webster, and Hay an option on the Australian rights to the Elmore bulk-oil process. In accordance with this agreement, Mr. Ballot and his associates sent ore to be tested at the Elmore laboratory, to which they had free access while the experimentation was in progress. In the agreement it was stipulated that the holders of the option "and their assigns" should notify the Elmore syndicate of any "improvement, addition, or discovery" that they might make and the Elmore syndicate was "to be entitled to every such improvement, addition, or discovery whether the same shall be patented or not."

Mr. Ballot and his associates made tests and held the option for 11 months, that is, until late in 1902. Messrs. Sulman and Picard were engaged by Mr. Ballot to supervise the tests. They were "treated with the greatest frankness," says Stanley Elmore. The option was not exercised. Then followed Mr. Ballot's purchase of the Cattermole patents and in the succeeding year the acquisition of the Froment and Sulman & Picard patents, followed immediately by the organization of Minerals Separation, Ltd., as a process-exploiting company. In 1905 the Elmores brought suit to enforce the clause above quoted, in the agreement of 1901, claiming that they were entitled to the benefit of the improvements following upon the insight into the process given to the Minerals Separation people during the tests made under the option. The case went against the Elmores, the Court of first resort deciding that the particular clause had been introduced into the contract without sufficient authority after it had been signed. In the second trial, Messrs. Ballot, Hay, and Webster presented evidence to show that the Cattermole and other patents had never been in their possession but had passed from the inventors through a trustee to the syndicate that became Minerals Separation, Ltd. Whereupon the proceedings were stayed. The affair left a feeling of bitter animosity between the two factions; the Elmores showed so keen a sense of betrayal as to resign from the Institution of Mining and Metallurgy when Mr. Sulman was nominated for the presidency of that professional society in 1911. This incident indicates the bitterness, rather than the merits of the quarrel, but it must be recorded in this history of the process because it helps to explain the

[11]Proceedings Aust. Inst. of M. E., November 10, 1913. The same engineer relates how, before 1901, "it had been long observed that a froth was formed containing high metallic values, in silver and lead particularly, whenever conditions were favorable, as for instance, where the rotation of trommels, or the splash of the elevators or raff-wheels, or the motion of the jig-plungers, produced a violent agitation of the mill-water containing slime." The use of oil tended to make such froth more persistent. I have mentioned the suggestion made by Beauchamp and Shellshear in 1902 while at work in this same mill.

[12]Not below 1%, apparently.

acerbity of the litigation that ensued and that still animates the protagonists in this metallurgical vendetta.

For three years, from 1906 to 1909, the Elmores fought Minerals Separation's attempt to hold a patent in Germany. The patent was granted, but it was annulled subsequently by a higher court.

In 1907 Minerals Separation brought suit against the Ore Concentration Company, alleging infringement of Froment's patent, but in 1909 the Minerals Separation company discontinued the action, paying costs.

In 1909 the Elmores and the British Ore Concentration Syndicate brought suit against Minerals Separation for infringement of Frank Elmore's bulk-oil patent of 1898 and Stanley Elmore's patent of 1901, specifying the use of acid in the bulk-oil process. They lost in the first court, they won on appeal, but lost on final resort to the House of Lords. Both the use of oil and of acid were held to have been anticipated, and the Minerals Separation froth-agitation process was held to be entirely different from the bulk-oil method. Subsequently a new suit was started in Australia, the claim of infringement against the Sulphide Corporation, a licensee of Minerals Separation, being based on acidulation. The Australian court decided against the Elmores, who appealed, unsuccessfully, to the Privy Council, in 1914.

Air-Agitation Methods

It is important to note that these suits dealt only with the bulk-oil patents of 1898 and 1901, and had no reference to the vacuum process of 1904. To the agency of gas in flotation we now return. So far the fact that bubbles of air would do the work of bubbles of chemically generated gases had been overlooked. In September 1903, Sulman & Picard described the use of air "or other gas" in British patent No. 20,419, which was duplicated in the United States as No. 793,808. In this they pictured a perforated coil of pipe through which either air is introduced into pulp with which oil has been already mixed or air and oil are admitted simultaneously in the form of a spray. The latter scheme has not proved practicable, whereas the procedure in which the oil is previously mixed with the pulp and then subjected to aeration by the introduction of air through the perforations in the pipe is a practical method. They said: "The oiled metalliferous particles resulting from either of the processes above described have the power of attracting to themselves, with a greater comparative strength than the gangue particles, the films or bubbles of gas which exist in the mass and are thus raised to the surface of the liquor by gaseous flotation." They did not claim the use of air as a discovery and they seem not to have known how near they were to the later phase of flotation, in which the making of a multiplicity of air-bubbles, or 'froth,' is the principal feature.

In June 1904 Frank Elmore applied for a patent to use electrolysis in order to generate gas in a freely flowing pulp, and in August of the same year he obtained British patent No. 17,816, in which he described the performance of flotation in a vacuum, so as to liberate "the air or gases in the milling water." Thus six years after the date of his first bulk-oil patent Elmore had learned to put the air to purposeful use. He subjected the oiled and acidulated pulp to a vacuum, thereby releasing the 2.2% of air normally absorbed in water. By lowering the pressure and raising the temperature this air is released, thereupon attaching itself, in the form of bubbles, to the oiled sulphide particles, which rise to the surface. For example, the air in a ton of pulp consisting of 6 parts of water to 1 of ore suffices to lift 360 pounds of zinc-lead sulphides in a Broken Hill ore. In actual practice, however, the weight of sulphides floated is considerably greater than the theoretical proportion as based on the efficacy of the air released from absorption in water. Part of the work is done by the gaseous carbon di-oxide liberated by the reaction between the acid and the carbonates, such as calcite, either in the gangue or added in the form of limestone. But a larger part of the bubbling is caused by the air entangled in the ore particles and entrained in the pulp during energetic mixing. In this process the quantity of oil added to the pulp was reduced from the ton used at Glasdir to 10 pounds per ton of ore, and finally to as little as 3 pounds per ton of ore. The machine devised by Mr. Elmore for the performance of his vacuum process was remarkably ingenious and to it the success of the process was largely due. It was applied at several Scandinavian copper mines, notably the Sulitelma, and also in the Zinc Corporation's mill at Broken Hill, as already mentioned.

This vacuum method of Elmore was a notable step toward the recognition of the part played by air in flotation, and insofar as he used air in a pulp that had undergone agitation with a relatively small proportion of oil he furnished a metallurgic sign-post that pointed to the final success of the process.

Flotation in America

So far flotation had received scant attention in the United States. The old Elmore bulk-oil method had been tried, unsuccessfully, at the Boston Consolidated and Mammoth mines in Utah in 1900 and 1901. In 1906 a surface-tension process of great ingenuity, invented by A. P. S. Macquisten, was used in the Adelaide mill, at Golconda, Nevada, and in 1911 a similar plant was erected at the Morning mine, in Idaho, but these interesting efforts were mere ripples on the calm surface of American apathy, which at the time gave no promise of the full tide of metallurgical advance that since then has swept over base-metal mining in the West.

Another American patent must be mentioned, as linking the Elmore bulk-oil process with the later frothing methods. The patent of Edmund B. Kirby is No. 809,959 of December 14, 1903. He used from 25 to 75% of oil in a flowing pulp; but he depended upon thin oil—kerosene—and violent agitation, so that he departed from the Elmore type of flotation. The more interesting feature of his claim, however, is "the injection of a gas, preferably air, into the mass," which statement, if taken with his reference to "allowing the hydrocarbon-coated

particles to float to the surface of the mass," seems indeed to be a forecast of froth-flotation. The patentee—Kirby—himself says: "It is thought that the use of a gas to assist in the flotation of the coated particles * * * is radically new in this art." He adds: "The employment of the gas in the manner stated brings in a more powerful floating agency than anything before used." How prophetic! His gas was "preferably air." Moreover, he knew of the use to be made of the air "dissolved" in water, as adopted a year later by Francis E. Elmore, for he says: "The air-bubbles not only tend to attach themselves directly to the coated particles, and thus float them to the surface, but the air becomes dissolved in the water to its maximum capacity. This dissolved air tends to again separate itself from the water and attach itself in minute globules to the coated particles." He used 'dissolved' as Elmore did, as an equivalent for 'absorbed,' for the air in water has not undergone solution. Mr. Kirby tried his process on a number of British Columbian ores, but no working plant was erected; nevertheless, it is apparent that he has not received proper credit hitherto for his ingenuity, and it is a pleasure to make the correction here.

The credit for bringing the froth process to the notice of the American public belongs to J. M. Hyde, who had been in the employ of a subsidiary syndicate organized by Minerals Separation for the exploitation of flotation in Mexico. Mr. Hyde was introduced to Mr. Ballot by Theodore J. Hoover, who, in October 1906, had been engaged by Mr. Ballot as technical adviser and general manager for the Minerals Separation company. In 1910 Mr. Hyde went to Mexico and early in 1911 he resigned, at the conclusion of his one-year contract with the syndicate. Shortly afterward he went to Montana, at the instance of H. C. Hoover, to inspect the property of the Butte & Superior Copper Co., this company having offered Mr. Hoover a participation in a bond issue. The business proving unattractive, Mr. Hoover withdrew from it, but Mr. Hyde commenced to investigate the metallurgical problem presented by the zinc-lead ore of the Butte & Superior company's Black Rock mine. After making the necessary tests with the slide machine, he erected a trial plant in disregard of the Minerals Separation patents. This was in August 1911, and not until the Butte & Superior company had negotiated with E. H. Nutter, the American manager for Minerals Separation, who demanded a prohibitive royalty. In October 1911 suit for infringement of patent was brought by Minerals Separation against Mr. Hyde.

Meanwhile, in December 1910, T. J. Hoover had severed his connection with Minerals Separation, after having been instrumental in the successful development of the company's business in Australia and in improving the various apparatus employed in the froth-flotation process, especially in that country. His resignation was accompanied by some friction with Mr. Ballot, into the details of which it is not necessary to go, but the fact is a part of the history of the process. In December 1912 Mr. Hoover published his book, 'Concentrating Ores by Flotation,' after a grudging consent had been obtained from his former employers, in return for which he excised parts of the original manuscript trenching too deeply into patent matters. This is recorded here in order to remove the impression, still persisting, that Mr. Hoover wrote and published his book while connected with Minerals Separation.[14]

We now return to Mr. Hyde and the commencement of a big litigation. The suit started against him in 1911 was tried first in the District Court of Montana and judgment was given against him in August 1913. On appeal, before the U. S. Circuit Court of San Francisco, this judgment was reversed in May 1914. By writ of certiorari the case was brought before the Supreme Court of the United States, which on December 11, 1916, reversed the decision of the Appellate Court and decreed that patent 835,120 was valid, but confined the scope of the patent to violent mechanical agitation, the use of less than 1% of oil, and a persistent kind of froth.

It is worthy of note that the first successful froth-flotation plant erected in the United States, by Mr. Hyde in 1911, did not start until six years after the grant of patent 835,120 and not until 20% of the world's production of zinc was being made by aid of the group of other flotation processes in use at Broken Hill. This may be compared with the statement of the U. S. Supreme Court, in its final review of the Hyde case, that "the process in suit promptly came into extensive use for the concentration of ores in most, if not all, of the principal mining countries of the world, notably in the United States."

The first successful application of the froth-flotation process in the United States was made at Butte, on a zinc-lead ore, as we have seen. The later development of the process has been based on the treatment of copper ores, especially the chalcocite disseminated in the immense ore-bodies disclosed in Arizona, Utah, and Nevada. This part of the story begins with the tests made by Minerals Separation in their London laboratory and in plants erected at sundry copper mines in other countries, such as the Caucasus Copper and the Great Fitzroy, with results generally poor. In his book, dated July 4, 1912, Mr. Hoover refers to the limitations of the process and says:[15] "The fourth limitation is one for which at present no adequate reason can be given. An ore in which the valuable minerals are wholly or partly bornite or chalcocite, as those of Bingham canyon, will probably give trouble to flotation processes, although not always, for among the many ores tested the one which gave the most uniformly satisfactory results was a copper ore assaying 2.8% copper, all in the form of microscopic specks of bornite." He proceeds to remark: "It may be that only those ores where bornite and chalcocite are of secondary occurrence give trouble." In Mr. Hyde's

[14] In mentioning these and other personal incidents, like the Elmore-Sulman & Picard affair, I am prompted solely by the desire to state facts essential to a correct understanding of the conditions governing the patent litigation, because they played a decisive part in the technical development of the process.

[15] 'Concentrating Ores by Flotation,' first edition, page 157.

report of January 8, 1911, given as an exhibit in the lawsuit, it is stated that the tests carried out in the Minerals Separation laboratory proved that "the copper ores of a good part of the Southwest and also of at least a portion of the Utah region contain chalcocite, *which is not floatable by any of the methods so far tested.*" This summarizes the opinion held by the Minerals Separation staff at that time. However, they discovered their mistake two years later. Tests on chalcocite ore from the Inspiration mine, in Arizona, were made in Mr. Nutter's laboratory at San Francisco during 1912, but the results were not good enough. At the end of that year, however, an 87% recovery on a 2% copper ore was obtained in a 15% concentrate. The telegram sent to the New York office of the company was mutilated in transit so as to state that a 50% concentrate had been obtained, and premature rejoicing followed.[16] Nevertheless the Minerals Separation staff promised good results and erected a 50-ton experimental plant at the Inspiration mine. The company took out a license early in 1913. On March 23 an experiment on low-grade chalcocite ore was made by T. A. Janney at the Arthur mill of the Utah Copper Company. This proved satisfactory. During that same month, March 1913, the Minerals Separation staff, at the Inspiration mine, had demonstrated a 90 to 92% recovery and a 35 to 40% concentrate on a 2% ore, with a 0.15 to 0.2% tailing. The presence of a colloidal kaolinized mineral diverted the oil from its proper function and interfered with the recovery of copper until G. A. Chapman suggested the addition of the oil to the ore in the tube-mill, where the metallic particles became oiled at the instant of exposing fresh fractures. These experiments warranted the expectation that on a 1.58% ore there would be obtained a 27½% concentrate with a recovery of 92% and a tailing loss of only 0.13%. A 600-ton Minerals Separation test-plant was erected in January 1914; in July of that year a pneumatic equipment consisting of five Callow cells and one Pachuca tank was added; and between August and October a Towne machine was in use. In 1915 the Inspiration Consolidated Copper Co. built a mill of 18 sections, each of 800 tons capacity, or a total of 14,400 tons daily. Since then this mill has treated as much as 21,000 tons in a day.

In June 1914 Mr. Chapman started flotation experiments at Anaconda in a 200-ton plant, obtaining 90% recovery. On February 1, 1915, the Anaconda and Inspiration companies signed a contract with Minerals Separation by the terms of which they agreed to pay royalty on a sliding scale ranging from 12 cents per ton on 4000 tons daily to 4 cents per ton on the treatment of more than 30,000 tons daily. By a curious proviso in the contract no royalty was payable on the 5000 tons between 10,000 and 15,000 tons daily. The tonnage coming under the terms of this agreement included the ore treated by sundry subsidiary companies, the consequence being that the maximum tonnage and minimum royalties specified in the agreement were reached by the close of 1916 at which time the Anaconda flotation plant was treating 14,400 tons daily. As an example of the saving made by aid of flotation, it is worth mentioning that whereas the tailing from the water-concentration mill used to assay 0.62% copper, the residue now after treatment in the flotation annex assays only 0.15% on a 3% ore; that is, out of 60 pounds of copper per ton only 3 pounds goes to waste, as compared with 12.4 pounds formerly. The recovery is 95%. Moreover, the metallurgical improvements made at the Washoe plant during 1915 were so effective as to enable an increase of 55,000,000 pounds per annum to be made in the production of the Anaconda company "without increasing the tonnage or grade of ore that has been mined in the past." So testified Mr. John D. Ryan, the president of the company in his annual report.[17] Further, he stated that "approximately 40,000,000 pounds of this increased production will be made without adding to the cost per ton of ore treated." This is the equivalent of the output from a big mine.

Meanwhile preliminary tests had been started at the Miami mine, which is a near neighbor of the Inspiration. From December 1913 to August 1914 the testing was directed by R. C. Canby, who used various types of apparatus, notably the Minerals Separation and Towne machines. On August 7, 1914, a pneumatic flotation plant was erected. The remodeled mill, having a capacity of 4200 tons, went to work on March 15, 1915. On July 14, 1914, Minerals Separation brought two separate suits based on patents 835,120 and 962,678, but these suits were dismissed on request of Minerals Separation, and on October 10, 1914, a single suit was started for infringement of three patents, the two already mentioned and No. 1,099,699.

Instead of using the blade-impeller type of agitator, the Miami Copper Company adopted the Callow machine, essentially a sloping launder with a canvas bottom through the pores of which air under small pressure is admitted into the pulp previously oiled. Such oiling of the pulp was aided at first by the use of a Pachuca tank, but in the spring of 1915 this type of agitator was found superfluous and since then the oil has been simply added to the pulp while flowing through a launder to the flotation-cell. In the trial of the suit before the District Court of Delaware, the defendant claimed that he was not using the agitation-froth process of patent 835,120 but a bubble method similar to that of patent 793,808, which was granted to Sulman & Picard on July 4, 1905, on an application dated October 5, 1903. In this patent a perforated coil of pipe is described, the idea being to admit air and oil in the form of spray, so that the globules of oil attach themselves to the metallic particles in the ore and float them to the surface. The pneumatic machine used at Miami was devised by J. M. Callow and patented as No. 1,104,755 of July 21, 1914. The idea had been used already in T. J. Hoover's British patent No. 10,929 of 1910. Mr. Hoover's patent was not duplicated in the United States and Mr. Callow was

[16] M. & S. P., March 18, 1916.

[17] M. & S. P., February 26, 1916.

unaware of it. Another investigator, R. S. Towne, had patented the idea previously, in the form of a carborundum wheel, the central hole of which he plugged, so that the wheel served as a porous bottom. The admission of air to make froth, without the aid of mechanical agitation, was developed in several machines at a later date—in 1915 and 1916—as has been duly recorded in the technical press.[18] The kind of froth produced by blowing bubbles of air through the pulp is claimed to be different from that made by beating air into the pulp with a mechanical stirrer; in the one case the froth is said to be thin, tender, and evanescent while in the other the froth is described as thick, coherent, and persistent.

However, the first trial-court decided in favor of Minerals Separation's contention that the Miami Copper Company was infringing its patent, 835,120, and also 962,678. The judgment was delivered on September 30, 1916, an appeal being filed at once by the defendant.

Patent No. 962,678 is important and interesting because it involves an idea to which no reference has as yet been made in this brief history of the process: I refer to the varying solubility of oils and the use of soluble agents for that modification of the surface tension of water to which the phenomena of froth-flotation or bubble-levitation are so largely due. The idea is not recent. Haynes, in his British patent of 1860, used coal-tar from gas-works in a rudimentary process of oil-flotation. Coal-tar contains as much as 20% soluble products. In U. S. patent 788,247, dated April 25, 1905, Cattermole, Sulman, and Picard used cresol and phenol, both soluble in water, as modifying agents.

On June 29, 1910, Sulman & Picard obtained U. S. patent 962,678 for a 'soluble frothing agent,' and this is the patent that the Miami company is charged with having infringed by reason of using cresol with pine-oil in its flotation operations. Application for this patent was filed on April 30, 1909. The illustration shows a beater form of agitator and "beating air into the mixture" is specified. Mention is made of "an organic compound in solution" and "amyl acetate" is instanced. No particular proportion of this "mineral frothing agent" is specified and an increase of the soluble substance is held not to interfere with the operation. The decision of the higher court on the validity of this patent will have an important bearing on the future of the flotation process, for it is manifest that the term 'soluble frothing agent' is extremely comprehensive and will frustrate legitimate attempts to avoid the embargo on the use of oil. Meanwhile the Supreme Court's recent decision validating the patent on the use of a 'critical' proportion of oil, namely less than 1%, has been stultified by successful concentration on a scale of 1000 tons or more per day when using 22 to 23 pounds of oil per ton of ore. At the same time comes the news of the Freeman process, in which soda-cake is being used successfully at Broken Hill as a modifying agent instead of oil. The litigation is far from ended and before it is closed it will be likely that oil will have been discarded in favor of other contaminants capable of lowering the surficial tension of water so as to permit the formation of a metallurgic froth.

In 1914 the flotation of oxidized lead ores became the subject of successful experiment, the method being to sulphidize the exterior of the oxides by means of sodium sulphide. This was accomplished so successfully that an effort was made in 1915 to apply the method to oxidized copper ores, which, however, are not readily amenable because the sulphidization penetrates the ore-particles so deeply as to interfere with the differential treatment and to consume an excessive amount of the sulphidizing agent. The treatment of zinc-carbonate ores by sulphide-filming has been even less successful, owing to the fact that such ores contain enough zinc silicate to interfere with flotation.

The story of flotation flows by devious ways and is broken by many cross-currents. Patents serve to record the high-water marks of ingenuity but they fail to disclose the movement between given points, and, what is much more important, they ignore the slow increase of manipulative skill. It is to manipulation, learned empirically in the laboratory and mill, that the flotation process owes its metallurgic success. Given the directions to be found in Kirby's or Froment's patents, the flotation expert of today can produce an effective result, without, apparently, borrowing from any later inventor. That is why the experiments made in Court have proved almost anything it was desired to prove. The manipulation to which success in the mill is largely due contravenes no patent and trespasses no man's preserves. A proof of this is to be found not only in the slow application of the flotation idea in metallurgy but in the delay that marked the fruitful use of the latest phase of the process. The froth-flotation that is claimed to be a new discovery is said to have been discovered in 1905; yet it was not introduced into an American mill until 1911, and even after that event the most skilful engineers, whether in the employ of the patent-mongering company or not, failed to apply it successfully for several years, not until 1914.

Haynes and Bradford left no trail. Everson failed to arrive, but it is likely that her patent put the idea of flotation into the heads of others, for example, Robson. He did not succeed, but he gave the clue to Elmore, who then prompted Froment and Kirby. Sulman was experimenting with the Cattermole method when he heard of Froment's scheme, and from that, I believe, he got the notion of using air to make a froth. Hoover, Callow, and other technicians, by the patient empiricism of the mill and laboratory, developed a workable process. Such, in brief, I believe to be the true pedigree of the flotation process.

[18] "The Kraut-Kollberg Flotation Machine.' By Max Kraut, M. & S. P., July 1, 1916. 'An Improved Pneumatic Flotation Machine.' By James M. Hyde, M. & S. P., November 25, 1916. 'The Porous Bottom.' By Rudolf Gahl, M. & S. P., September 30, 1916. 'Flotation in the Clifton-Morenci District.' By David Cole, M. & S. P., October 14, 1916. 'Flotation at the Calaveras Copper Mine.' By Hallet R. Robbins, M. & S. P., November 25, 1916

Electrical Precipitation in Metallurgical Plants

By R. W. Kerns

*Introduction. When a gas is in an ionized condition and passes an electro-static field its ions begin to travel at a high velocity in the direction of one or the other of the electrodes causing the field. If the electrodes are charged to a high potential they become the ionizing agents as well as the source of the propelling force. These highly charged ions are continually bombarding any solid particle that may be in the field and impart a charge of like potential to the particle, which in turn begins to travel toward the electrode of opposite polarity. If one of the electrodes is a sharp point or a small wire, a greater stress is set up, resulting in greater ionization from this electrode only. Thus the gas receives a static charge of this same polarity. A striking illustration of the ionization due to points is shown by the old experiment of blowing out a candle by means of a highly charged needle.

Practical advantage is taken of these principles in electrical precipitation. The gases to be treated are caused to traverse metallic tubes at a velocity not greater than 12 ft. per second. Each of these tubes becomes an electrode, while the other electrode is formed by a fine wire stretched along its central axis. A uni-directional potential of from 25,000 to 250,000 volts is applied, charging the solid or liquid particles in the gas and causing them to be deposited on the inner surface of the tube. The dust is collected at intervals by vibrating the tubes and thus shaking the dust into bins. At these times both the current and the gases are shut off from the section of tubes being cleaned.

Historical. That dust suspended in gases could be removed by electrical discharge was suggested nearly a century ago. In more recent years Sir Oliver Lodge rediscovered the same phenomenon and suggested its application to purifying the atmosphere and eliminating soot or other objectionable matter from smoke. The first attempt to use the principle commercially was made at the Dee Bank lead works in 1885. Wimshurst influence-machines were used as the source of electrical energy. These machines lacked the requisite capacity and stability of potential, and hence the first patents were allowed to expire without successful use. Twenty years later Lodge again revived interest in the subject by patenting the use of the new mercury-arc rectifier as applied to the electrical precipitation of suspended particles. It remained, however, for F. G. Cottrell, of the University of California, further to develop the process. Following extensive laboratory experiments, he succeeded in having his invention installed in the DuPont Powder Co.'s plant at San Francisco for precipitating sulphuric acid mists. The process was soon after adopted by the Selby Smelting & Lead Co., at San Francisco, whose chimney-gases had become a nuisance because they contained so much sulphuric acid, arsenic, and lead salts.

Preliminary experimentation was necessary at both of these places and many disappointments and obstacles were met and overcome before these plants were operating successfully. Electrical precipitation is now used or being installed at the following plants: Washoe smelter, Anaconda; Garfield smelter, Garfield; Raritan refinery, Perth Amboy; Omaha smelter, Omaha; Goldschmidt Detinning Co., Chicago; International smelter, Tooele; and the Trail smelter in British Columbia. At most of these plants the recovery of copper, gold, silver, or lead is sought. At Anaconda electrical precipitation is used to collect white arsenic. Two treaters in series are used and the dust is separated from the arsenic by fractional precipitation. The gases enter the first treater hot and the dust is collected. By admission of air the gases are then cooled from 310 to 90° C., and in the second heater pure white arsenic is collected. Fractional precipitation thus

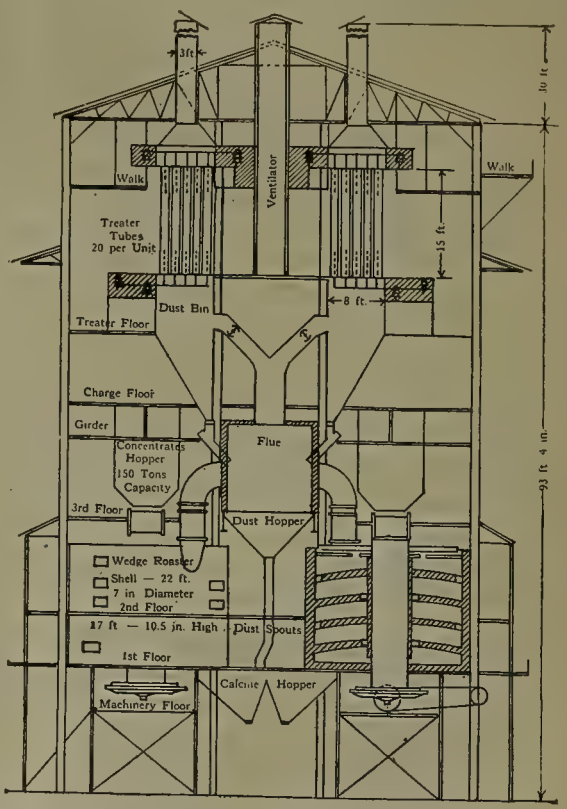


Fig. 1. Precipitation plant of the International Smelting Company.

*Abstracted from *The Electric Journal*, to which we are also indebted for the illustrations.

renders the refining furnace unnecessary. At Anaconda another large installation is also being made to handle the gases from the roasters.

At the Bureau of Mines station at Pittsburg an interesting plant is used to precipitate soot from boiler-gases. One of the earliest plants was built by the Riverside Portland Cement Co., in California, where 900,000 cu. ft. of gas per minute is being treated and about 90 tons of cement-dust precipitated per day. The wide application of the process is also shown by a recent installation for the precipitation of powdered food, such as powdered milk or cream and powdered eggs; also in the removal of tar from illuminating gas and recovering chlorine in bleaching-powder works.

At Miami. Two precipitation plants are installed at this smelter, one of which treats the gases from the roasting or drying furnaces and the other treats the converter-flue gases. The main object of both of these equipments is to recover the copper that would be lost if these gases were discharged directly into the atmosphere. At most modern copper plants this saving has been accomplished by building enlargements in the flue, or large dust-settling chambers. But experience has demonstrated that a more complete recovery may be obtained by electrostatic precipitation.

A cross-section through the roasting-plant is shown in Fig. 1. The precipitation apparatus is mounted over the drying-furnaces and is provided with 12 chimneys, 30 in. diam. by 30 ft. high, for discharging the treated gases into the air. This arrangement was chosen over the alternative scheme of bringing the gases down to treaters on the ground-level. A single chimney conducts the treated gases away and provides draft.

The electrode-tubes are 13-in. welded-steel pipes 15 ft. long. They are belled outward at each end to reduce the brush-discharge at these points. Twenty of these tubes, together with other accessories, make up a unit, which has its own gas-intake, chimney, and electrical connections. The gas can be shut off from one of these units by means of dampers, the switches opened and the tubes vibrated by means of mechanical hammers to shake the collected dust into a hopper beneath. Twelve such units comprise this plant.

The other and ungrounded electrode is a No. 20 nickel-chrome-steel alloy wire. A light steel frame, supported on insulators, enters the hood through glass windows. One such frame is used at the top to support the electrode-wires, which are spaced at the bottom by a similar frame. A five-pound weight at the bottom of each wire holds it taut.

The gas consists almost entirely of air with a high percentage of water-vapor and carbon di-oxide, at a temperature of about 80° C. The gas also is permeated with a fine dust carrying about 25% copper. About five tons of this dust is collected per day. The efficiency obtained is practically 100%; no visible material can be seen escaping from the exit-stacks under normal operation.

No trouble is experienced in the operation of this plant, provided a temperature is maintained sufficiently high to prevent the condensation of moisture in the tubes. Such moisture would not only make the precipitate a sticky mud, which would be difficult to dispose of, but, together with any sulphur tri-oxide that is certain to be

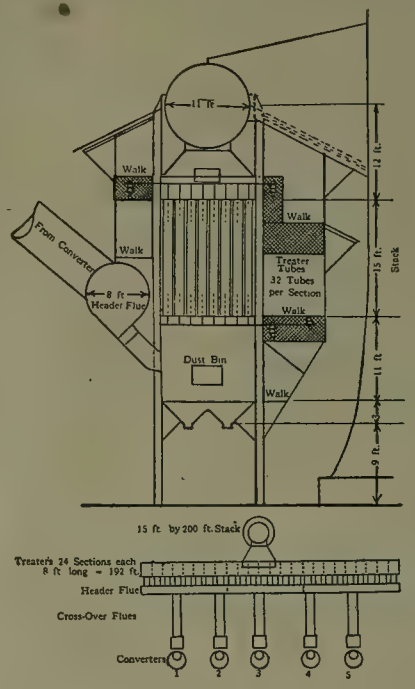


Fig. 2. Precipitation Plant at Miami, Arizona.

present in small quantity, would hasten the destruction of the treater itself by corrosion.

Converter-Plant. This gas differs from the roaster-gas by having the higher temperature of about 200° C. and by being dry and containing a large percentage of SO_2 and SO_3. In order to treat the larger volume of gas

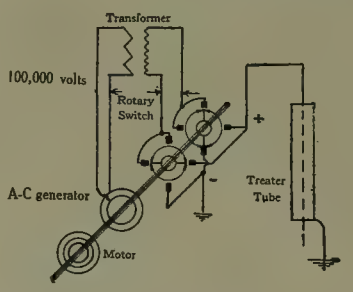


Fig. 3. Electrical Connections of Apparatus.

the units were made to include 32 thirteen-inch tubes each. The five converters deliver their gases to one common header-flue. The 24 units of the precipitation plant draw their gas from this flue and discharge upward into another common header, which leads to a 15 by 200-ft. chimney. As in the dryer-plant, the collected dust is shaken down into bins placed over standard-gauge tracks. A covered and dust-tight lorry-car transports the dust directly over the reverberatory charge-hoppers, through

which the dust passes into the furnaces. The velocity of the gas is six feet per second, based on a total volume of 250,000 cu. ft. per minute.

The principal change made in the treaters since the original installation has been the housing in of the treater-units with corrugated iron placed about each set of tubes. The reasons for doing this were three-fold: First, it was found that the wind chilled the tubes on one side, which caused most of the gases to pass up the tubes on the other side of the treater. This unequal distribution of gas is cumulative, the hot tubes becoming still hotter owing to the large volume of hot gases going through them, while the cold ones soon cooled off entirely and took no gas at all. This effect is being avoided in the latest installations by adopting down-draft tubes, in which this effect of chilled tubes is self-corrective instead of being cumulative. Second, the chilling of the dryer-gas condensed moisture and sulphuric acid on the tubes, as referred to above, is entirely obviated by housing them in. Third, in the converter-plant the maximum of draft is desirable and can be obtained only by keeping the gas entering the main stack as hot as possible.

Electrical Apparatus. In order to obtain a uni-directional current at from 60,000 to 100,000 volts, a rotary switch is used to rectify the current of a high-potential transformer. Two arms carrying a segment of copper plate at each end are mounted on a shaft at right angles to each other, as in Fig. 3. The arms are insulated from the shaft and from each other and revolve between the adjustable brushes, which clear the plates by a half-inch. Electrical synchronism is obtained by driving an alternating-current generator directly connected to the switch. This generator furnishes the primary current of the transformer as well as the means of voltage-control by variation of field-resistance. The generators and transformers each have a capacity of 15 kva. There are eight of these electrical sets operating at about two-thirds capacity, besides two spare units. This means a power consumption of 16 watts-seconds per cubic foot of gas treated.

Metallurgy at Cobalt in 1916

*The outstanding development in the metallurgy at Cobalt in 1916 was the increased use of flotation. Plants are now in operation or in construction at the Buffalo, McKinley-Darragh, Dominion Reduction, Coniagas, Beaver, Trethewey, Northern Customs Concentrator, National, and Nipissing mines.

The Buffalo has the largest plant, rated at 600 tons per day. The large pile of concentrator tailing will be re-ground in tube-mills and treated by flotation, along with the regular output of the mine. For the most part, flotation is confined to the treatment of the fine material that formerly went to the slime-tables. This material, assaying about 6 to 8 oz. silver, yielded poor extraction on slime-tables, but by the new process it can be reduced to 1 to 2 oz. The equipment for floating the regular concentrator-slime is cheap, and the feed comparatively rich. The next step will be more costly, that is, the re-crushing of the sand-table tailing in tube-mills, followed by flotation. The feed will average about 3 oz. silver. The profit on this will, therefore, be less.

The Callow pneumatic cell is used generally throughout the district. Machines of the impeller type have not been thoroughly tried, though several Groch machines are working. The Kraut-Kollberg machine has also been used. The Callow cell has acquired many new details in Cobalt practice. Transverse baffles reaching to within two or three inches of the bottom prevent surging. In several mills the froth is allowed to overflow only at the tailing end of the cell; in another the froth collects at four different levels in the cell and cascades over the baffles from one compartment to the next, overflowing at the feed end. These two devices raise the grade of the concentrate on this ore. Whether they will result in a higher tailing remains to be seen.

*Abstract from article by R. B. Watson. *Can. Min. Jour.*, March 1, 1916.

The flotation of the residue after cyanide treatment has been the subject of a great deal of experimenting at the Nipissing, but the result is still far from satisfactory. It was thought that the presence of 0.04% cyanide and 0.03% alkali in the pulp solution was the cause of the poor extraction. This was remedied with acid, but results were no better. The most likely explanation is that the cyanide treatment changes the surface of the mineral particles to such an extent that these particles do not readily float. The objection to flotation is the cost of marketing the concentrate. Only one smelting concern in Canada or the United States will buy this product at present. The marketing costs on 200, 300, and 400-oz. concentrate are 22, 16, and 13%, respectively. Hugh Rose, commenting on Santa Gertrudis practice, states that flotation concentrate from that silver ore can be treated raw by cyanide, giving a high extraction. The same treatment on Cobalt concentrate gives poor results and it is necessary to roast with salt before attempting to leach. With good chloridization there should be little difficulty in extracting the silver by cyanide or by sodium hyposulphite.

T. R. Jones at the Buffalo has completed a plant for the treatment of this flotation product. The concentrate is pumped to a thickener feeding to an Oliver filter. The necessary salt is added in solution to the cake before it is scraped from the filter-drum. The concentrate is dried in an oil-fired revolving cylinder, is crushed and fed to a hearth-furnace. The calcine is pulverized in a Hardinge ball-mill, mixed with an acid solution to dissolve the oxidized copper, and then drawn on the leaves of a Moore filter. Subsequently the leaves carrying the pulp are immersed in caustic-soda solution to neutralize the remaining acid and then transferred to the cyanide-tank. Most of the silver is extracted in the short treatment on the filter leaves. The residue is pumped to the cyanide-tank, where it receives further treatment and then goes to flotation.

Metallurgical Methods at Treadwell

By S. B. Combest

The Alaska Treadwell, Alaska Mexican, and Alaska United gold mines are operated under one management and are commonly called the Alaska Treadwell group. The Alaska Treadwell mills consist of two plants, the 240 and the 300 mills—540 stamps in all. The names of the mills correspond to the number of stamps in each unit. The Alaska Mexican has a mill of 120 stamps. The Alaska United has two mills, the 700 and Ready Bullion, each containing 150 stamps. The total number of stamps in the mills of the group is 960. These several mills, except the Ready Bullion, are supplied from a central crushing-plant, the broken ore being hauled by electric motors to the various bins. At the central crushing-plant, the mine-run of ore is crushed without screening in two No. 12 (K) Gates gyratory machines, delivering to two 5 by 14-ft. trommels, having 2-inch apertures and revolving at 13 r.p.m. The oversize from the trommels goes to four No. 6 (D) Gates gyratory crushers, where the rock joins the undersize from the trommels, and is conveyed by two 40-in. belt-conveyors to a concrete bin of 2000-tons capacity. A sizing-test of the ore at the bins gives the following:

Size	%	Size	%
On 3-in. ring	6.0	On 48-mesh	0.80
" 2-in. "	28.2	" 65 "	0.65
" 1-in. "	29.25	" 100 "	0.65
" ½-mesh	10.11	" 150 "	0.80
" 4 "	11.65	" 200 "	0.53
" 20 "	7.80	Through 200 "	1.33
" 35 "	2.23		

About 4526 tons of ore is crushed daily.

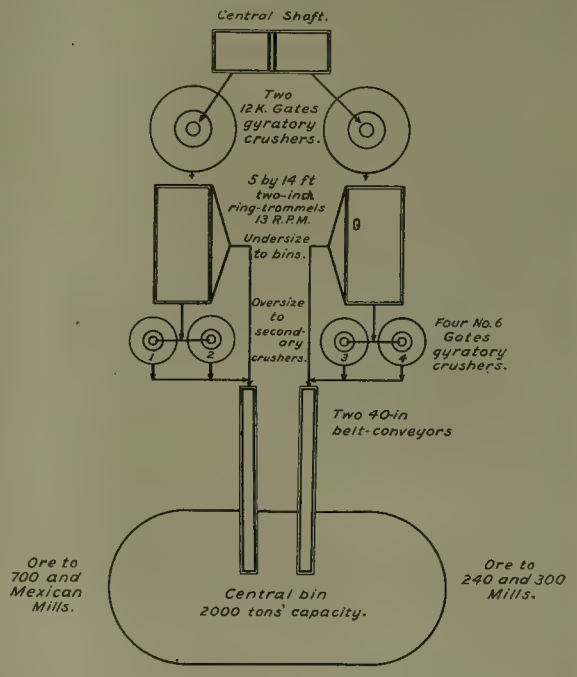
The Ready Bullion mill is three-quarters of a mile from the other mills, and receives its supply of ore from a separate crushing-plant, at the mine. This ore goes to the mill on a gravity tram, the empty cars being hauled back to the mine by a small hoist. As the metallurgical practice is the same in each of the mills, a description of the methods at the Ready Bullion will suffice for all. The mine-run of ore is dumped from a skip onto a grizzly, the undersize going to the pocket beneath, the oversize to No. 6 (D) Gates gyratory crusher, the crushed ore joining the under-size in the pocket.

The mill-bins have enough capacity for a 48-hours run. The ore is fed to the batteries by suspended Challenge feeders. The stamps weigh 1239 lb. each for the 300, 700, Mexican, and Ready Bullion mills, but the 240-mill has 1003-lb. stamps. The weight of the stamps is distributed as follows: tappet, 180 lb.; shoe, 175 lb.; head, 594 lb.; stem, 490 lb. The weight of the mortars is 7312 lb.; of the cam-shaft (5½ in. by 8½ ft.), 675 lb.; cam, 225 lb.; die, 140 lb.; cam-shaft pulley, 1275 lb. Total weight of a 5-stamp battery, 17,282 pounds.

The sequence of drop is 1-3-5-4-2; the height of drop is 9 in.; the number of drops per minute, 100; height of discharge above the die, 6 inches. The ratio of water to pulp, as fed to the battery is 5:1. The average stamp-duty is 4.71 tons per 24 hours, crushed through 20-mesh. The total daily tonnage in 1915 was 4526. The finished product from the stamps gives the following sizes:

Size	%	Size	%
On 20-mesh	6.25	On 100-mesh	8.35
" 35 "	25.00	" 150 "	12.50
" 48 "	12.50	" 200 "	6.25
" 65 "	12.50	Through 200 "	16.65

AMALGAMATION. Mercury is fed into the batteries in all of the mills, although amalgamation on inside copper


Central Shaft.
Two 12K. Gates gyratory crushers.
5 by 14 ft two-inch ring trommels 13 R.P.M.
Undersize to bins.
Oversize to secondary crushers.
Four No. 6 Gates gyratory crushers.
Two 40-in belt-conveyors
Ore to 700 and Mexican Mills.
Central bin 2000 tons' capacity.
Ore to 240 and 300 Mills.

COARSE-CRUSHING PLANT AT THE CENTRAL SHAFT.

plates has long since been discontinued. A more thorough mixing of pulp and mercury takes place when the mercury is fed into the mortar-box. The amalgam is collected on outside copper plates that are cleaned-up once each month. The plates are 5 ft. wide and 10 ft. long, and have a grade of 1 in 12. About 51% of the recoverable gold in the ore is won by amalgamation. The loss of mercury averages about 30% of the amount used, about 0.3 oz. of mercury being fed for each ton of ore crushed. The plates are dressed once in 24 hours. The general clean-up is made once a month, the practice being to allow the amalgam to accumulate on the plates.

CLEAN-UP. The plates are steamed for an hour to

PANORAMA OF THE TREADWELL GROUP OF MINES ON DOUGLAS ISLAND, GASTINEAU CHANNEL, AND THE MAINLAND ADJACENT TO JUNEAU.

soften the amalgam. This renders its removal with the knives an easy matter. The accumulated amalgam is put into a barrel with sufficient mercury to make the charge fluid. About 300 lb. of 3-in. iron balls are added and the barrel is filled about three-fourths full of water, after which the man-hole cover is made secure, and the barrel started revolving. It is run over-night. In the morning the small tap-hole opposite the man-hole is opened and the barrel again revolved. In this manner the contents are slowly discharged into a 4-ft. batea. To the charge in the batea are added five or six 6-in. iron balls, and the batea is then started and kept in motion until all the slimed concentrate has worked to the surface and is washed off. This is collected and returned to the battery. The batea is then stopped, the iron balls taken out, the metallic iron removed from the amalgam by means of a magnet, the mercury screened through an eight-mesh screen—a gold pan with $\frac{1}{8}$-in. holes punched in the bottom. The portion remaining upon the screen is called 'base bullion' and is kept separate.

The screened mercury is then passed into canvas bags that are placed in a hydraulic amalgam-press, where the excess mercury is squeezed out. The dry amalgam thus obtained is worth about $6.30 per ounce.

LATER. Since this was written, amalgamation has been discontinued at the Treadwell mills. All the value of the ore now is recovered from the concentrate.

CONCENTRATION. The mill-pulp, after passing through ordinary mercury-traps, contains 49% of the recoverable gold. From the traps the pulp goes to Frue vanners. These machines are 6 ft. wide in all of the mills except the 240 and Mexican, where they are only 4 ft. wide. There are two vanners to each five stamps. The belts are set on a grade of $4\frac{3}{4}$ in. from centre to centre of the travel-cylinders. The number of vibrations is 196 per minute, and the belt-travel 5 ft. per minute. Each vanner treats about 12.5 tons of pulp per 24 hours. The practice is to run the machines so that the concentrate will carry about 35% sand, which seems to afford the most satisfactory result. The tailing leaving the vanners assays 16.5 cents in gold and is allowed to run to waste.

The concentrate from the vanner-boxes is shoveled daily into cars and taken to the cyanide plant for treatment.

MILLING COSTS. The average cost of milling one ton of ore at each of the several mills in 1915 is given below:

	240 mill	300 mill	700 mill	Mexican mill	Ready Bullion mill
Crushing	$0.038	$0.038	$0.037	$0.040	$0.022
Tramming	0.014	0.016	0.015	0.016	0.019
Stamping	0.211	0.189	0.170	0.192	0.182
Concentrating	0.066	0.059	0.052	0.058	0.070
Cyaniding	0.087	0.087	0.088	0.092	0.086
Total	$0.416	$0.389	$0.362	$0.398	$0.379

CYANIDE PRACTICE. The cyanide plant is adapted to the all-sliming method of treatment, and handles all the concentrate produced in the five mills.

A 75-hp. electric hoist hauls the cars to the bins, where samples are taken with an auger while the concentrate is still in the cars. Two samples are taken from each car. The cars are then weighed, moisture determinations made, and the contents computed, after which the cars are dumped by tipples into two 100-ton conical steel bins. From these bins the concentrate is fed directly to Abbé tube-mills. There are three of these, two 5 by 22 ft. and one 4 by 16 ft., each equipped with the spiral feed. The larger mills will grind about 90 tons of concentrate in 24 hours. As the total concentrate sent to the grinding-plant daily is about 105 tons, the second of the larger mills is used as an auxiliary when the concentrate begins to accumulate.

The smaller tube-mill is placed between the larger ones and below the tube-mill floor. This particular mill is charged with 2-in. iron balls and is used to remove the metallic iron from the main circuit, otherwise the battery-iron would accumulate in the grinding-circuit and reduce the capacity correspondingly. The small mill is operated with four tons of balls, on a charge of about the same weight. This mill makes $30\frac{1}{2}$ r.p.m. and is driven by a 50-hp. motor.

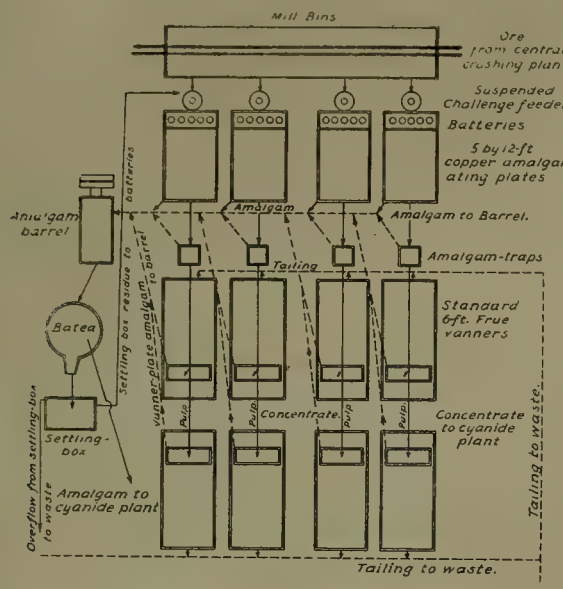
The larger tubes make 28 r.p.m. and are loaded with 10 tons of $2\frac{1}{2}$-in. Danish pebbles. The load of concentrate weighs about the same. Each mill is driven by a 100-hp. motor. The discharge is distributed equally to four 5 by 16-ft. Dorr duplex classifiers, the oversize being returned. A separate classifier is used to dewater the material going to the smaller tube-mill, the feed from which is drawn from the coarse return to the large tubes. The discharge from the small 'tube' is then elevated into the main circuit, the metallic iron having been ground to pass 200-mesh, after which it overflows with the slime.

The discharge from the tube-mills is dewatered in a $4\frac{1}{2}$ by $21\frac{1}{2}$-ft. Dorr thickener, the thickening apparatus making one revolution in 8 minutes. A 1-hp. motor drives this mechanism, and a 2-in. valve controls the thickened product. The ratio of ore to solution on entering the thickener is as 1:4; on leaving the thickener it is 1 of solution to $1\frac{3}{4}$ of ore. The overflow is clear and goes to the gold-sump. The thickened pulp is sent to twelve 10 by 30-ft. Pachuca tanks, or Brown agitators. The charge for a tank is 40 tons of pulp, to which 30 to 40 tons of barren solution is added. Agitation is then commenced and continued for four hours, when the charge is allowed to settle for 8 hours. The clear solution is decanted, going to the gold-sump. Solution is again added and agitation recommenced and continued four hours as before. This is done three times. The total time of treatment of a charge in these tanks is 81 hours, distributed as follows:

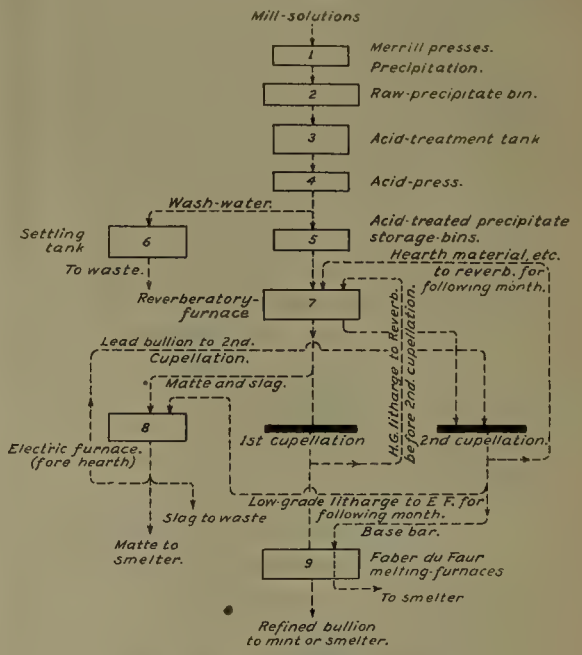
	Hours
Filling	8
Agitation	12
Settling	29
Decanting	29
Adding solution	1.5
Agitating and pumping residue to double cone	1.5
	81.0

After the third agitation in a Pachuca tank the charge is pumped to a double-cone storage-tank, which is used as a storage-reservoir for the filter-presses.

Filtration. All of the solution decanted and the overflow from the thickener are gathered in three 75-ton sump-tanks from which this solution is forced through a clarification-press by a 6-in. pump, the clear liquor going to the precipitation-room. Pulp from the double-cone classifier is drawn into the filter-press, where it is given a wash with barren solution, after which the moisture is reduced to about 12% by compressed air. The press is



FLOW-SHEET OF STAMP-MILL AT TREADWELL.



FLOW-SHEET OF TREADWELL REFINERY.

then sluiced with water and the pulp discharged to the waste-dump. The time required to each charge in the press is as follows:

Operation	Minutes
Filling	10
Filtering	6
Blowing back pulp	8
Filling with wash-water	10
Washing	20
Blowing back wash-solution	5
Drying with air	30
Sluicing pulp	80
Total time	2 hr. 49 min.

The capacity of the Treadwell presses is 16 tons of dry pulp. Formerly two Kelly presses were used, and they are still occasionally employed for this purpose. The capacity of the Kelly presses is 3 tons of dry pulp, and their operation requires 45 minutes, the discharge containing 12% moisture.

Precipitation. All of the clarified solution is sent by an Aldrich triplex pump through five Merrill precipitation-presses. An emulsion of 0.2 lb. of zinc-dust and 0.5 lb. of lead acetate is added at the suction end of the pump. The strength of the solution is raised here to 1.7 lb. cyanide per ton, which is the standard strength of solution throughout the mill, and practically all the cyanide added is introduced at this point. The head-solution contains on an average of $8 per ton gold, and the tailing-solution from the presses is kept down to 5 cents per ton. The barren solution is run to a large storage-tank from which it is pumped as required. Each of the five Merrill presses holds 800 lb. dry precipitate. The filter-cloths are of heavy sheeting, covered with two thicknesses of filter-paper. The presses are run until the gauge indicates a pressure of 35 pounds.

Refining. When the precipitation-presses are cleaned the solution is shut-off and the precipitate is washed with fresh water. The moisture is then blown down until the dripping from the discharge-cocks ceases. This generally requires 45 minutes. The presses are then opened and the precipitate dropped into pans, from which it is shoveled into steel boxes and taken to the refinery, where it is weighed and dumped into a steel storage-bin. From this bin the precipitate is taken out as needed for acid-treatment. After acid-treatment the precipitate is given a wash with hot water and is then pumped into a Merrill press and the moisture-content blown down to about 20%. The press is then opened and the precipitate transferred to the small steel storage-bins near the reverberatory furnace. The precipitate is taken from these bins and, without further drying, is mixed with fluxes and charged to the furnace. The gold is collected by lead and the lead cupelled, leaving gold bullion about 0.890 fine. All the by-products, such as high-grade slag, litharge, matte, sweepings, and hearth-materials, are re-smelted. Melting is done once in each month.

An analysis of concentrate gives the following:

	%		%
Fe	41.8	SiO_2	32.0
S	21.37	Al_2O_3	1.20
CaO	2.18	Au	$45

The iron occurs in the form of pyrite, pyrrhotite, and marcasite. As pyrite is only slightly affected by exposure to the atmosphere, it is the decomposition of the pyrrhotite and marcasite that introduces the cyanicides. The reaction is supposed to be:

$$FeS_2 + 7O + H_2O = FeSO_4 + H_2SO_4$$
$$H_2SO_4 + 2FeSO_4 + O = Fe_2(SO_4)_3 + H_2O$$

Calcium sulphate is slightly soluble in water, and more so in cyanide solution, unless other soluble sulphates are present. Lead acetate is added to the solution as it comes in contact with the concentrate. Barium chloride was used to some extent in place of lead acetate to replace some of the sulphates entering the solution and gave better results, but the present high price of barium chloride has led to the substitution of lead acetate. To prevent oxidation the concentrate is kept under water at the mills until it is shoveled into cars just before treatment begins. About 5.4 lb. of lime is added to the concentrate in the cars and the charge becomes well mixed by the time the concentrate comes in contact with the cyanide solution. The following reactions then take place:

$$Ca(OH)_2 + FeSO_4 = Fe(OH)_2 + CaSO_4$$
$$H_2SO_4 + CaO = CaSO_4 + H_2O$$
$$3CaO + Fe_2(SO_4)_3 = 3CaSO_4 + Fe_2O_3$$

The reaction with barium chloride in the presence of calcium sulphate is:

$$BaCl_2 + CaSO_4 = BaSO_4 + CaCl_2$$

The lead acetate is added to the concentrate as it enters the tube-mill, the amount being 0.35 lb. per ton of concentrate.

Losses and Extractions During Treatment

During the grinding cycle:	
Loss of cyanide	0.90 lb.
Loss of lime	5.40 "
Consumption of lead acetate per ton of ore	0.35 "
Extraction during grinding	75%
During classification, transit, and thickening:	
Loss of cyanide	0.02 lb.
Loss of lime	0.01 "
Extraction	4.40%
First treatment in Pachucas, or Brown agitators:	
Loss of cyanide	0.70 lb.
Loss of lime	0.33 "
Extraction	10.5%
Second treatment in Pachucas:	
Loss of cyanide	0.23 lb.
Loss of lime	0.33 "
Extraction	3.5%
Third treatment in Pachucas:	
Loss of cyanide	0.30 lb.
Loss of lime	0.33 "
Extraction	3%
During filtration:	
Loss of cyanide	0.08 lb.
Loss of lime	0.08 "
Extraction	1%

The ratio of the total amount of solution used in classification, grinding, agitation, and in the washing-presses is about 6.5:1. The total amount of solution treated in the precipitation-presses is about 500 tons. On entering the cyanide-plant the concentrate contains 12.5% moisture and it leaves carrying about the same proportion. During each Pachuca treatment 5 lb. of lead acetate is added; protective lime is carried at 1.75 lb. per ton of solution; and the cyanide content at 1.7 lb. free cyanide. The total consumption of cyanide per ton of concentrate is 2.23 lb.; of lime, 6.48 lb.; and of lead acetate, 0.69 lb. The total extraction is 97.03%.

As the concentrate contains traces of copper, the solution gradually becomes charged with an appreciable amount of it, which necessitates the addition of lead acetate at the presses. The acetate added in the mill is entirely precipitated by the sulphur compounds before entering the Merrill presses. So an additional quantity is added here. From an examination of the zinc, it is evident that the copper and the gold cover the zinc in such a manner that no further action is possible between the zinc and the solution. The addition of the lead acetate at this point probably results in the following reaction:

$$Pb(H_3C_2O_2)_2 + Zn = Zn(H_3C_2O_2)_2 + Pb$$

The lead acetate in contact with metallic zinc serves to precipitate metallic lead, in the form of a sponge; this, with the excess of zinc sets up a galvanic reaction sufficient to cause the gold and copper to be precipitated in a loose and pulverulent form, which readily scales off from the zinc, permitting further action between the zinc and the pregnant solution.

The analysis of the zinc-dust gives the following:

	%		%
Total zinc	90.7	Iron	1.3
Metallic zinc	85.0	Insoluble	9.55
Zinc oxide	5.0	Through 200-mesh	96.0
Lead	1.9		

Refining. The dry weight of precipitate received at the refinery each month is about 6500 lb. From 1500 to 1700 lb. of raw wet precipitate is taken from the bin. The agitator in the acid-tank is started, one ton of hot water is admitted, and the precipitate is then charged slowly, after which sulphuric acid is added. As soon as the violent reaction has subsided a sample is taken of the liquid, which is tested for acidity with methyl orange. If the sample is alkaline, more acid is added and the solution again tested. This is continued until the solution is slightly acid. The tank is now filled with hot water, the agitator being kept in motion. The capacity of the tank is 10 tons, of which about 8 tons is water. The agitator is then stopped and the solution allowed to settle. The clear liquor is siphoned off and pumped through the acid-press, which is a 20-frame Merrill precipitation-press. The frames are covered with several leaves consisting of 22-oz. duck, drilling, sheeting and two filter-papers. The waste solution runs about $0.08 per ton. The acid-pump is a plate-lined 3-in. Byron Jackson centrifugal. After the first wash is off, the agitator is again started and the tank re-filled with hot water and the sludge pumped into

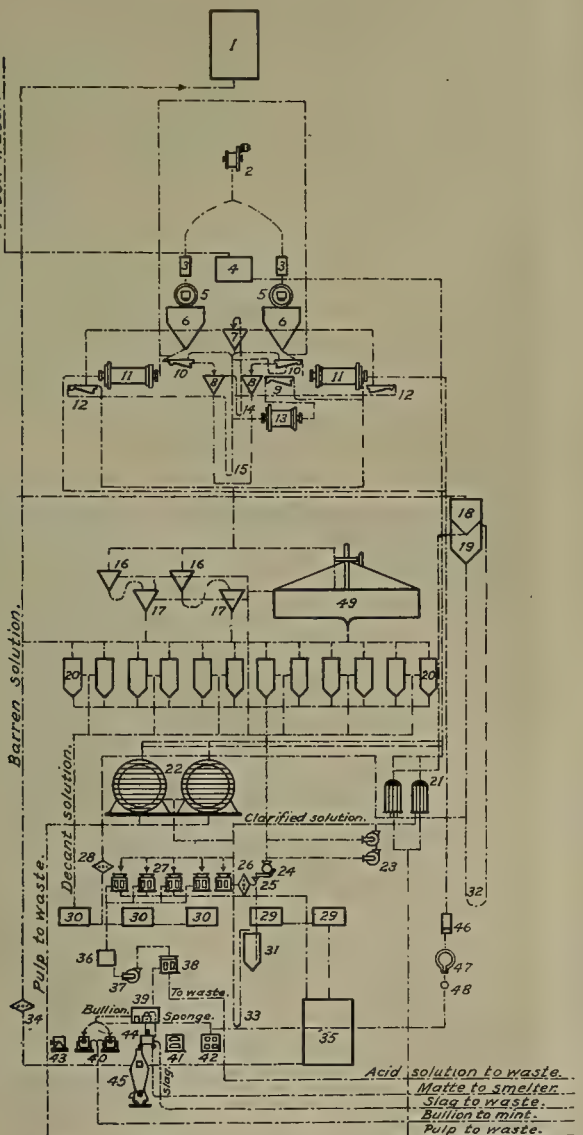
the press, which holds about 700 lb. (dry weight) of precipitate. All of the raw precipitate is treated in this manner. The treated precipitate is placed in the small steel bins near the furnace.

Analysis of precipitate both before and after acid-treatment gives the following:

	Before treatment	After treatment
	%	%
Au	10.0	16.0
Ag	0.6	1.2
Cu	8.0	16.96
CaO	15.0	2.6
S	2.8	10.0
Fe	0.7	1.4
SiO_2	0.45	1.0
Zn	50.0	4.0
Pb	11.6	24.0
Al	0.2	0.4

A flux is calculated from the above analysis. The S is considered as a Cu, Fe, Pb, Zn matte. About 20% of lead in the first-run matte gives the best grade of bullion. If all of the lead is reduced, copper is also thrown down and causes trouble during cupellation. The remaining lead is thrown down from the matte in a separate fusion. The lime, alumina, and a part of the zinc is calculated as forming a mono-silicate slag. The method of calculating the flux-charge is: the copper into Cu_2S (matte), the iron as FeS, 20% of the zinc as ZnS. The remaining zinc is calculated as ZnO in a silicious slag.

The usual charge for the furnace is 250 lb. (wet weight), of precipitate, which is equivalent to about 200 lb. dry weight. The precipitate, which is not dried before smelting, has been determined by careful analyses to contain the constituents shown at the top of the following page:



1. 1800-ton solution storage-tank.
2. 75-hp. electric hoist.
3. Two Osgood track-scales.
4. 50-ton fresh-water tank.
5. Two car-tipples.
6. Two 100-ton cone-bottom bins.
7. Callow cone-classifier.
8. Two Callow cone-classifiers.
9. Dorr duplex classifier.
10. Two Dorr duplex classifiers.
11. Two 22 by 5-ft. Abbé tube-mills.
12. Two Dorr duplex classifiers.
13. 4 by 16-ft. Abbé tube-mill.
14. Cone-classifier air-lift.
15. Coarse-return air-lift.
16. Two Callow dewatering cones.
17. Two 2nd stage dewatering cones.
18. Double-cone storage (W.S.)
19. Double-cone storage (pulp).
20. Twelve 10 by 30-ft. Pachucas.
21. Two Kelly filter-presses.
22. Two Treadwell presses.
23. Two 4-in. Byron Jackson centrifugal pumps.
24. Automatic zinc-dust feeder.
25. Zinc-dust mixer.
26. 7 by 9-in. Aldrich triplex pump.
27. Five Merrill precipitation presses.
28. 7 by 9-in. Aldrich triplex pump.
29. Two 75-ton storage-tanks.
30. Three 75-ton gold storage-tanks.
31. Gold solution Pachuca tank.
32. Pulp air-lift to D.C. storage.
33. Gold-solution air-lift to Pachuca.
34. 7 by 9-in. Aldrich triplex pump.
35. Barren-solution storage.
36. Acid-treatment tank.
37. Plate-liner Byron Jackson pump.
38. Merrill acid-press.
39. Reverberatory-furnace.
40. Two Faber du Faur furnaces.
41. Muffle-furnace.
42. Retort-furnace.
43. Tilting-furnace.
44. Electric-furnace (fore-hearth).
45. 20-in. blast-furnace.
46. Amalgam-barrel.
47. Batea.
48. Amalgam-press.
49. Dorr thickener (4½ by 21½ ft.).

FLOW-SHEET OF CONCENTRATE-TREATMENT PLANT.

	Lb.		Lb.
Copper	33.9	Iron	2.8
Sulphur	20.0	Zinc	8.0
Lime	5.2	Lead	48.0

The practice here is to allow 3.75 lb. of copper to one of sulphur. Therefore the copper content will satisfy 9.04 lb. of sulphur. The iron, as FeS, will take up $2.8 \div 1.75 = 1.6$ lb. of sulphur; 20% of the zinc, as ZnS, equals $1.2 \div 2 = 0.6$ lb. of sulphur. The lead content of the matte at 20% is equivalent to 1.6 lb. of sulphur. The total combined sulphur is therefore:

	Lb.		Lb.
Cu_2S	9.04	PbS	1.60
FeS	1.60		
ZnS	0.60	Total	12.84

An additional 10% of the sulphur is allowed for loss by oxidation in the furnace, this accounts for 2 lb. more, a total of 14.84. As there was 20 lb. of sulphur in the charge, there still remains 5.16 lb. to be expelled. To accomplish this, metallic iron in the form of strips of old battery-screens is added in the following ratio: $5.16\ S \times 1.75$ (the iron factor) $= 9.03$ lb. of screen to be added. The lime is calculated as follows:

$SiO_2 : 2CaO :: 1 : 1.85$ or $5.2 \div 1.85 = 2.81$ lb. of SiO_2 to be added. An excess of 10 lb. of silica and 15 lb. of soda-ash is also added to the charge. The lead is reduced with pulverized coke, which is added at the rate of 1 lb. of coke to 10 lb. of lead.

A charge is made up in the proportions indicated and brought to a state of fusion. The silica and iron are then regulated according to requirements. If the slag is too thick, the silica is lessened, if too thin, running off like water, leaving a thick pasty mass on the surface of the matte, silica is added. The thick mass is generally zinc that has not entered either the matte or the slag, and an excess of silica will take it up. The proportion of iron is decreased if a crust begins to form on the jacket of the hearth. If the matte indicates, by its crystalline structure, that there is not enough iron present, more iron is added. A charge will ordinarily consist of:

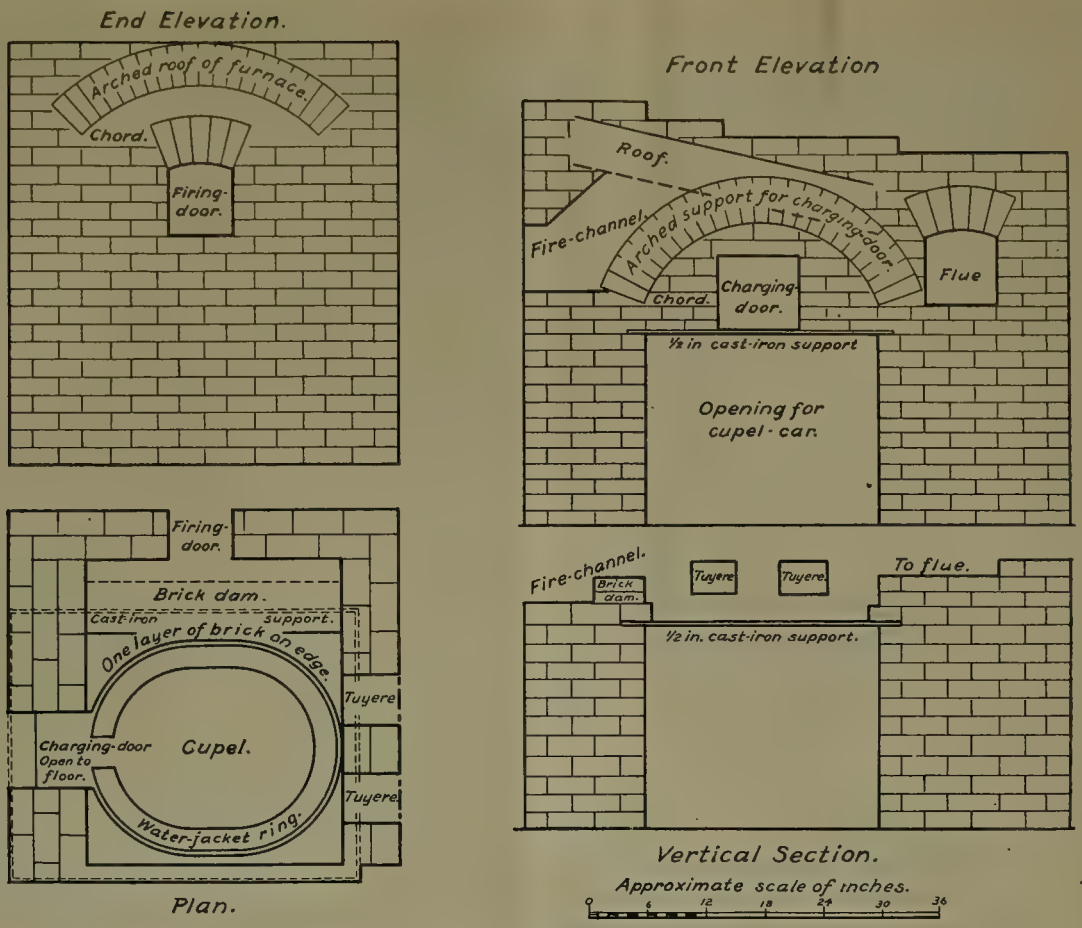
	Lb.
Precipitate (wet weight)	200.0
Iron (screen-scraps)	9.03
Silica	12.81
Soda-ash or crude borax	15.0
Coke	4.80

This is charged into a small reverberatory furnace, burning crude-oil. The hearth of this furnace consists of a horse-shoe cast-iron water-jacket, closed at the open end with magnesite bricks, which are used as the lip of the hearth. The space inside the jacket is filled and tamped solid with a mixture consisting of 200 lb. of limestone, crushed to pass an 8-mesh screen, 70 lb. cement, and 20 lb. of water. After tamping, the centre is hollowed out to shape. In starting the furnace a seasoned hearth is run under the car-support and the sides are luted carefully with fire-clay. The hearth is bolted to the perforated cast-iron plate-bottom. The hearths are made up several weeks before they are required, and are allowed to dry slowly, which prevents checking. A wood fire is started on the hearth and the furnace heated gradually. As soon as the hearth is hot enough, sufficient lead is introduced to cover the bottom of the hearth. A few shovelsful of matte are added, which helps to start fusion. As soon as this is melted, the charge is added. The heat is not allowed to rise much above the melting-point of the charge. After quiet fusion the slag is stirred with an iron rabble and allowed a few minutes to settle. Then the slag is tapped. A shovelful of cold slag is thrown on the surface to prevent any moisture in the succeeding charge from coming in direct contact with the molten matte. When all the material has been smelted, the slag and matte are drawn off separately as far as possible and a shovelful of lime thrown over the surface of the bullion to thicken the remaining slag, after which it can be safely skimmed off with the iron rabble. The bullion is now ready for cupellation. As the slag is tapped from the hearth it is allowed to flow into a small electric furnace, used as a fore-hearth. This furnace is provided with wheels and can be run back when the reverberatory furnace is being charged. Litharge and ground coke are added to the fore-hearth and the molten slag is allowed to stand until ready for the next tapping of the reverberatory. The electric fore-hearth is now tapped into slag-pots. The lead is drawn off at intervals from a separate tap-hole, which is a few inches lower than the slag-tap. By this method the reverberatory-furnace slag is lowered from $50 per ton to between $1 and $4 per ton in one operation. The lead bullion from the fore-hearth is added to the reverberatory and cupelled down. The matte, litharge, and last few charges of slag are re-run in the reverberatory furnace, passing through the fore-hearth as in the previous operation.

CUPELLATION. When the surface of the bullion is clean the blower is started and air is blown across the surface of the charge toward the charging-door. The air-pressure should be sufficient to cause slight ripples on the surface of the molten mass. The lip of the hearth is cut-down to the level of the lead and the hearth tilted slightly, until the litharge begins to flow.

Care must be exercised in tilting the hearth, otherwise lead bullion will flow over. A wide smooth lip is best. The presence of small bubbles or globules indicates that metallic lead is overflowing. An examination of litharge caught on a shovel will show whether metallic lead is escaping. In case lead is overflowing, the hearth is tilted back until the lead ceases to show. If there are no other impurities present than lead, zinc, sulphur, and a small amount of copper—2% or less—the addition of a quantity of lead equal to the weight of gold present will clear the bullion of these impurities. If much copper is present more lead will have to be added to effect this.

Toward the end of cupellation a dark line will appear, beginning directly under the tuyeres and gradually working toward the overflow. This advancing line marks the division between the fine gold and the base metal floating on its surface. The molten gold should now present a bright mirror-like surface, though the



PLAN AND SECTIONS OF REFINING-FURNACE.

metal is likely to bubble and boil a little at this period. As soon as the dark line passes over the lip of the furnace, the refining is complete and the bullion is poured into molds of about 500 oz. capacity, the bottoms of which have been covered previously with dry borax-glass to prevent spattering. As it has been found impossible to pour a satisfactory bar directly from the hearth of the reverberatory, the bullion is cast in the small molds, as above described, and later melted in a Faber du Faur tilting-furnace, and cast from this into molds having a capacity of 2000 ounces. During the last few minutes of cupellation the heat is raised in the furnace to oxidize the last of any lead that may remain and to keep the gold molten, the refined gold requiring a higher heat. In case much copper is present and there is not sufficient lead to absorb and remove it, the surface of the bullion will appear dark-red and a slight crust will appear. If it is necessary to bring the bullion up to a higher degree of fineness, more lead is added and cupellation continued until the surface of the metal is mirror-like. The by-products of the first run consist of matte, approximate weight 800 lb.; litharge, 600 lb.; hearth-material, 150 lb.; slag, 400 lb. It has long been the usual practice here to make an analysis of the matte before re-melting to determine the gold, sulphur, lead, copper, and silver contents.

RE-SMELTING. The same hearth is generally used to re-smelt the by-products. A charge is made up of the following: matte, 40 lb.; litharge, 30 lb.; hearth-material, 7.5 lb.; slag, 20 lb. Metallic iron is introduced to combine with the sulphur released by the lead. Coke is added to reduce the litharge, and about 5 lb. of silica and 8 lb. of soda-ash are also added to combine with the oxides of iron, formed during smelting. The slag is tapped into the electric fore-hearth and treated in the same manner as in the previous smelting.

Analyses of the matte before and after re-smelting generally approximate the following:

	Before	After
Gold	$212.90	$11.57
Silver	123.90	53.01
Copper	38%	35.1%
Lead	16.7%	2.9%
Zinc	2.9%	5.2%
Sulphur	20%	19.8%
Iron	7.7%	16.9%

The matte from the fusion is crushed, sampled, and sacked. When a sufficient quantity has accumulated it is shipped to the smelter, the copper content more than

paying the expense. The slag averages about $2 per ton and is thrown on the dump. The hearth is broken up and the portion containing metallics is smelted at the next melt. The remaining portion is re-ground and used again. The fire-brick and furnace-chipping are ground in the amalgam-barrel, the coarse gold amalgamated, and the fine sent to the tube-mills to be cyanided. The average value of this ground material is about $100 per ton. Refinery sweepings and flue-dust are run with the regular melt, being introduced at the rate of 10 lb. with each charge.

The gold, after cupellation, is weighed into the quantity desired for each bar and this is melted in an oil-fired Faber du Faur tilting-furnace. The bullion is sampled, when molten, by the 'dip' method. It is thoroughly stirred with a graphite rod before taking the sample. A half-inch hole is bored in a piece of graphite, which is then heated to redness. This graphite sampler is plunged into the centre of the molten gold. It is then removed and allowed to cool, when, generally, the slug of gold will come out clean, so that the sampler may be used again. The average weight of bars is 1800 ounces. After casting, the bar is allowed to stand until the gold has solidified, after which it is doused and cooled with water and the slag hammered off. It is then treated with concentrated nitric acid, washed with water, the gold dried and weighed.

Amalgam. The mill amalgam is brought to the refinery each month, retorted, cast into bars, sampled, weighed, and shipped to the Mint. The amalgam from each mill is weighed before retorting and 99% of the difference in weight between the amalgam and the sponge after retorting is returned to the mill as metallic mercury. The loss of mercury in retorting is slightly less than 1%. The retort-furnace is of the double-cylinder type. The amalgam is packed in 'boats' that are placed in the retorts. Usually it requires two charges to treat all of the amalgam. After charging and carefully sealing the retort, the furnace is fired slowly, the heat being increased gradually for about 7 hours, when it is raised to a bright-red to drive off the last of the mercury. The furnace is then allowed to cool somewhat, and the cover of the retort is removed, the boats withdrawn, and the sponge of gold taken out, weighed, and melted. This bullion is sampled in the same manner as the cyanide bullion, but it is marked and kept separate. The difference between the Mint returns and the Treadwell returns on shipments aggregating $270,000 averaged $107. The Mint assays are slightly lower than those at Treadwell. The difference in weight of the bars was 0.52 oz., the Mint weight being the lower. These figures are on gold only.

Base-Bullion. The amalgam containing the base-bullion is retorted each month to recover the mercury, the sponge being stored until sufficient has accumulated to make a bar weighing from 600 to 1000 oz., when it is melted in a Faber du Faur furnace. As the molten metal attacks the crucible, an old crucible is generally used for this melt and is discarded afterward. To 1000 oz. of base 'sponge' are added 5 lb. of silica, 5 lb. of borax-glass, and about 3 lb. of sulphur (the latter to form matte with the iron). A part of the copper also goes into the matte. The resulting bars run from 20 to 100 fine, the base being principally copper. These bars are shipped to the smelter. The total monthly cost of retorting, smelting, sampling, and casting the amalgam into bars is $87, of which the labor cost is $58, and supplies $29. The cost per fine ounce is $0.012.

Magnesium

*The metallurgist has been coquetting with magnesium for half a century. We can get its oxide cheaply and in abundance, its salts are not difficult to prepare, we know their properties to a considerable extent, we know almost all the properties of the metal which bear on its isolation, yet the industry lags and halts. To prepare by tedious methods the anhydrous double chloride, and then to electrolyze it about as Matthiesen did fifty years ago, is nearly all that can be said with certainty about its present metallurgy. At any rate, using magnesium oxide costing a few cents per pound, the metal sells for about as many dollars per pound, and there is still a scarcity. W. M. Grosvenor, in a paper before the American Electrochemical Society, summarizes the present methods of production and the uses of the metal. He also suggests the great field open for radically new methods of production. The point of attack should be to reduce the oxide directly. The halogen salts are hygroscopic, and the halogen is destructive of the reducing apparatus. It is almost certain that proper research will enable the electrometallurgist to feed magnesium oxide (MgO) directly into an electrolytic bath of fused salts, and take magnesium or magnesium alloy from it. The pure metal will float on almost any fused salt, but alloys with heavier metals may be made that will sink, and many of its alloys have immediate useful applications.

The possibilities in the metal industry from having reasonably cheap magnesium are interesting. The stiffening of magnesium to produce strong alloys with a specific gravity not over 2, has not been properly studied. It is possible that alloys analogous to dur-alumin may be discovered, as strong as soft steel and only 30% of its weight, useful in aeroplanes and dirigibles. Such alloys may also largely displace aluminum alloys in the automobile industry, with a saving in weight, which will compensate for higher first cost. The uses of magnesium will also be extended for deoxidizing brass, bronze, nickel, and Monel metal, since it is a much stronger deoxidizer than aluminum. In fact, aluminum has blazed the way to numerous uses for which magnesium, as soon as it becomes cheaper, will compete and replace its older sister. Magnesium ore is as plentiful as that of aluminum, and there will inevitably be a large future for magnesium as one of the common metals of every-day life.

*Abstract of article in *Jour. Ind. & Eng. Chem.* V. 8, No. 8, p. 736, by J. W. Richards.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

MEXICO CITY

RESTORATION OF LANDS TO INDIANS.—METALLIC MINERALS AND PETROLEUM NATIONAL PROPERTY.

The new constitution is a fact that must be confronted by all foreigners doing business in the Republic, wherefore comment from one on the ground may be useful. In the first half of the third paragraph of article 27, the nation is given the right to control all lands and waters in the public interest, even those transferred to private possession. In the second half of the paragraph is begun the treatment of the problem of the Indian communal lands, the appropriation of which by the Diaz *científicos* helped to bring on the present revolution. In declaring their restoration to the Indians a work of 'public utility,' the first step toward the solution of the problem is taken. The placing of all metallic minerals under national ownership is merely a recognition of an established fact, for Mexico, like most other Latin countries, has never conceded anything more than a lease-hold to metallic deposits. Formerly this was also the case with non-metallic minerals, but by the mining law of 1883 these were granted to the owners of the surface rights. This was done by the Gonzales administration. The evils of that law as applied to petroleum land have become generally recognized. The resumption by the government of ownership to non-metallic minerals, as now proposed, without any attempt to relieve their present private owners of disability flowing from the change, is however, a violent method of handling the problem. In the sixth paragraph, where the national ownership of minerals and waters is declared 'inalienable and imprescriptible' and their private possession is made contingent on their proper development and use, a stand is taken in the public interest which is far in advance socially of anything yet attained by the United States. The sole right of acquiring the ownership in lands and waters, and concessions for working Federal minerals and waters is bestowed upon Mexican citizens only. At the pleasure of the Government, however, foreigners may be conceded the same privileges on condition of renouncing the protection of their home governments under pain of forfeiture.

Fraction IV attempts to limit the monopoly of agricultural land by prohibiting its ownership by stock companies and strictly limiting the area owned by mining and industrial companies. This would be of doubtful utility if applied only in the future, but, as it applies to the many existing companies and will greatly injure or ruin them, it must be characterized as unjust. The ancient privilege of communal administration of egidos was unwisely taken from the Indians by the law of 1856, and its restoration is essential for the well-being of these communities. Fraction VII, by prohibiting a civil corporation from owning, managing, or loaning money upon real estate, except the buildings is another attempt to limit land monopoly; but like all arbitrary restrictions upon the free play of individual industrial activity, it is of dubious value. The ninth paragraph voids nearly all the transfers of the land of the Indian egidos that have taken place since the process begun by the law of 1856. A few classes of titles are not wholly repudiated, but the owners are allowed to retain only 50 hectares each (123.5 acres). Most titles to the communal lands seem to be repudiated by this decree, even when derived through actual purchase from the Indians. Thus many mining companies are in danger of losing their surface holdings. Whatever the injustice to the Indians from the deslinde (survey) laws of Diaz, it certainly only aggravates the past wrongs to now dispossess indiscriminately and without compensation nearly all present holders of egido lands, many of whom have spent their savings in improving them. Disregarding entirely the Mexican statute of limitation for fraud, fixing 20 years as the limit, this decree by unsettling such titles dating 60 years back, promises a carnival of graft by the corrupt legal profession of Mexico. Compared with this gross violation of vested rights, the Zapata 'Plan of Ayala' for the restitution of the egidos seems moral and moderate. Each State legislature is given power to decree the maximum area of ground that a single owner can legally possess. Any excess over the assigned limit must be divided up by its owner with the time and under the conditions to be prescribed. If the owner refuse to carry this out his property will be expropriated. The owner must accept for his excess lands an annuity which cannot be larger than that required to amortize the sale-value in 20 years, or to allow 5% interest. The owner must accept payment in a new issue of State bonds, and an 'inalienable family patrimony' is provided for, evidently intended to prevent the present landowners from collecting anything at all from the land-buyers in case the new State bonds prove worthless; an event not at all unlikely in view of the recent scandalous history of Carrancista finance. This whole scheme is a thinly-disguised legal veil for effecting the benevolent program of the anarchist 'Regeneracion' of Los Angeles, California, to confiscate Mexican rural property and distribute it among the peons.

Article 33 is derived from the old one of the same number, but goes further in its anti-foreign animus. Formerly the expulsion of 'pernicious' foreigners was authorized, and these could appeal to their ambassadors to establish their innocence. By permitting the Mexican president 'to expel any inconvenient foreigner without trial' the new article illustrates the impudence reached by the anti-foreign faction as a result of three years of non-interference, either at home or from abroad, with their vicious propaganda. All important offices, like that of state governor, supreme judge, senator and deputy can be held only by native Mexicans. By these prohibitions Mexico would be deprived of the political services of talented naturalized foreigners.

The labor rules seem to be derived from those of New Zealand, without considering the differences in character of the laboring people there from those in Mexico. Limiting a day's work to 7 or 8 hours simply means that Mexico's annual output will be only 80% of what it might be under the 10-hour day, the one best suited to the present untrained condition of the peons. Establishing the minimum wage and the right of workmen to share in their employers' profits puts Mexican industries at the mercy of the local Boards of Conciliation, that fix the amount of each. It changes employers into mere salaried managers for their workmen, who would become the real owners of all enterprises. These provisions of the constitution will doubtless cause not only the ruin of the owners of great enterprises, but a reversion of such establishments to a simple medieval type, which is the only one that can be understood by Mexicans. Requiring cash wage-payments, along with the clause providing for wage payments to be made at least once a week, will destroy the system of many mining companies, which involves monthly pay-days and guaranteed grocery stores. The monthly pay means monthly instead of

weekly debauches, while the guaranteed stores provide food for the families and allow the men only some surplus cash for wasting on booze.

In a sort of apology for the constitution, recently published by Licenciado Rojas, president of the Constituent Assembly, he states that 60% of the lawmakers were military and unused to legal constructions. If he had added to this admission the fact that hardly a dozen of the non-military lawmakers were competent to legislate on natural resources or industrial relations, he would have improved his statement. The corrupt ex-Minister of Education, Palavicini, was one of the leaders in framing the confiscatory anti-religious legislation and as he is personally a Catholic adherent, it is rumored that he was paid by the Jesuits to make the constitution so absurd and unjust as to win friends for the reaction. The anarchist projects were inserted through the influence of Gen. Cándido Aguilar, vice-president of the Constituent Assembly and Minister of Foreign Relations. Aguilar represented Vera Cruz with its I. W. W. locals of the great cotton-mills of Rio Blanco. He was a poor Vera Cruz farmer in 1911, but his patriotic struggles have made him a multi-millionaire.

However it originated, the new constitution is a legal fact and has to be faced as such, both inside and outside of Mexico. It can be altered only by an amendment initiated by two-thirds of those voting in Congress and approved by a majority of the State legislatures. By the confiscatory clauses of Art. 27 and 123, all industrial and religious property in Mexico has been as neatly laid open to legal spoilation by the Carrancistas as a basket of fat oysters might be pried open by a sharp knife for one of the banquets so often given to the First Chief. The Carrancista leaders consider the world as it is rather than the world as it ought to be. Threatened with the loss of foreign credit if they proceed to enforce their constitution, they can wisely afford to take the risk in exchange for an unlimited opportunity of rewarding the faithful with the tangible foreign property already planted in Mexico.

JOPLIN, MISSOURI

JOPLIN DISTRICT ABLE TO MEET ALL DEMANDS FOR ZINC.—NEW STRIKES DAILY.

From the standpoint of preparedness for the supply of zinc and lead for munitions for our national use, in case of war, the Joplin district is in a position of unusual importance at this critical time. Never in the history of the district has there been such a production of high-grade zinc-blende ores available for 'brass special spelter.' The Joplin district can supply from 8000 to 12,000 tons of high-grade zinc-blende, of which 60 to 65% would be of such a grade as to meet the requirements for spelter used in the manufacture of brass shells. In addition to this, there is a potential production available of 4000 to 6000 additional tons by the end of June. Besides this great contribution of one of the necessities to the national defence, the Joplin district, together with south-east Missouri, can supply an equal quantity of high-grade pig lead.

Besides this material advantage and a readiness for preparedness there is the spirit of co-operation among the operators of the district to aid in the defence of the country to a degree far beyond that accredited by the press of the country to the Middle West. It was from a meeting of the Joplin district's mine operators that one of the earliest and strongest endorsements of President Wilson's armed neutrality law was sent to the President and to the district's Congressional representative.

The outstanding feature of new developments of the district consists in the remarkable number of new strikes now being made in the Waco field at the northern extremity of the Joplin district. This new field is at the northern end of the new trend of ore development, and the character of the new strikes has been so rich that they have attracted even more attention that the older well-known districts at the other end of the developed territory at Cardin, Picher, and Century, in Oklahoma. All of the work so far consists of drill-prospecting, none of the shafts having yet penetrated into the ore-horizon. The drill-prospecting, however, reveals ore running from 80 ft. in depth to 160 ft., giving a thickness of 80 ft. of ore. The depth at which the ore is found varies from 80 to 160 ft. and has been found as deep as 235 ft. Cuttings run from 3½% in the poor holes, to as high as 35% in the better holes. There is sufficient prospecting work already done to demonstrate the existence of a large field, and the acreage taken up in leases is rapidly approaching an amount already existing in the Oklahoma part of the region. Some of the operators who have already made very rich strikes in their prospecting of leases are Thomas Coyne of Webb City, Missouri; Frank Danglade and associates of Webb City, Missouri; T. J. Franks of Joplin, Missouri; Newton Bros., of Miami, Oklahoma; Charles Windbigler and associates of Miami, Oklahoma; and the Acme Mining Co. of Carl Junction, Missouri. All of these concerns have made rich strikes, and there are a dozen or more new concerns drilling in the new field. With the activity now under way and the excitement already so great, it is believed there will be as extensive a drilling campaign in this field as in the Miami, Oklahoma, and Baxter Springs, Kansas, fields.

NEVADA

MINING LEGISLATION SOUGHT.—DEVELOPMENTS AT MANHATTAN AND GOLDFIELD.

Numerous bills of interest to mining men have been introduced in the present session of the legislature. One measure authorizing a bond issue of $500,000 for construction of a State custom smelter aroused much interest and developed a tie vote in the assembly. Numerous complaints are being made to the legislators by small-mine operators to the effect that the smelters are charging excessive rates for handling of custom ore, or are refusing shipments. Most of the smelting companies are unable to handle all of their own ore, which probably accounts for the inability to accept small custom shipments.

Another bill has been introduced in the interest of the labor unions. It prohibits the courts from granting injunctions against striking miners, or from interference with them when seeking shorter hours or higher wages. Other measures pending relate to workmens' compensation, State aid for prospectors, and improved mine conditions. The high metal prices and increased dividends earned by numerous Nevadan companies have encouraged bills for higher mine taxation.

After lying dormant for practically ten years, Manhattan has again taken a prominent place among Nevadan camps, as a result of important developments on the 435-ft. level of the White Caps mine. Aside from the statement that the orebody averages around $50 per ton the management is giving out little information, preferring to wait until further developments establish the dimensions of the orebody. Development has been resumed on the 300-ft. level. Equipment for the mill and roasting-plant is arriving, but it will be several weeks before the plant will be ready for service. The owners of the Morning Glory, adjoining the White Caps, have arranged to sink the shaft deeper in hopes of intersecting the White Caps vein-system. The mill of the Union Amlagamated has been placed in operation. There is 200 tons of ore on the dumps and arrangements are being made to draw ore from the 600-ft. level of the recently un-watered Bath shaft. The vein at this point is free-milling and 5 ft. wide. Assays are said to average around $20 per ton. The Big Four, Manhattan Consolidated, Gold Wedge, and other companies are preparing for more work. Considerable placer mining is still being done in the neighboring gulches. Unusually heavy snow insures an active placer season.

George Wingfield, president of the Nevada Hills Mining Co., operating at Fairview, announces that the corporation is seeking another mine, as the ore possibilities of the Nevada Hills have been apparently exhausted. The quickly convertible assets are placed at approximately $351,002, including $70,734 in cash. Several properties have been presented for consideration. The company is advertising that leases on Nevada Hill ground may be secured on favorable terms.

Goldfield conditions are steadily improving. The Goldfield Consolidated Co. has started vigorous developments in the Laguna mine, with attention for the present chiefly confined to the 260-ft. level, at a point 440 ft. south of the shaft. A fair tonnage of $10 ore is being sent to the mill from this level. Ore averaging $14 to $15 per ton is coming from the 450 and 600-ft. levels of the Mohawk. It is reported extensive work will be resumed shortly in the Grizzly Bear mine, adjoining the Atlanta group.

The Red King claim of the Florence-Goldfield group has been taken under lease by the Red Hills-Florence Co. The lease permits development to a depth of 650 ft., the area to be 1000 ft. long and 500 ft. wide. Work will be carried on from the 800-ft. Red Hill-Florence shaft. This shaft has been repaired to the 250-ft. level and three shifts of miners are continuing the work to the bottom level. An excellent plant has been installed.

The Orleans Mining & Milling Co. is shipping $40 ore from its Hornsilver mine, in the Hornsilver district. On the 400-ft. level the vein is 6 ft. wide and is developing well. The company was recently reorganized with J. W. Dunfee, president and manager, and C. Terwilliger, secretary. A. H. Elftman is consulting engineer. The Silver Mines Corporation is grading for a 100-ton cyanide-plant and preparing to build an eight-mile water-line. The incline shaft has been straightened for a length of 300 ft. and will form the main working outlet.

The branch road of the Nevada Copper Belt Railway to the Bluestone mine has been completed, and ore shipments are going direct to the Mason Valley smelter. The plant is treating 750 tons of ore daily, the product coming from the Bluestone and Mason Valley mines.

TORONTO, CANADA

Potash a By-product of Cement-Making.—The Nickel Question Again.

Potash is being produced in commercial quantity in Ontario by the National Portland Cement Co., of Durham, which is turning out 12 to 16 tons per day, as a by-product of its cement output. This development, which is regarded as highly important, in view of the great demand for potash and the large quantity of the raw material, feldspar, that is available, is due to a series of experiments by Allen Grauel, who came to Canada from Pennsylvania three years ago, and since has been working out his process at the Durham plant. By addition of feldspar to the limestone used in the cement manufacture, the quantity of potash escaping with the fumes was largely increased, and a process was perfected by which it could be collected. The plant is now producing 2000 tons of cement daily, on which basis the output of potash would be 15 tons. Both muriates and caustic potash are produced, and it is claimed that the former is almost pure. Additional installations are being made which will increase the potash output to 20 tons per day. Although feldspar deposits abound throughout Ontario and Quebec and development began about 1890, the industry has languished for want of a convenient and profitable market. The highest yearly output was in 1914 when 18,060 tons was produced. Practically all the Canadian output is consigned to American potteries, the cost of freight preventing the profitable working of all except a few deposits within easy access of the border. Now that a home market has been opened a rapid development of the feldspar resources may be looked for.

Since the opening of the Ontario Legislature last month the politicians have been at it, hammer and tongs, over the nickel question, which has now become almost entirely a party issue, most of the recalcitrant conservatives, who were disposed to object to the Government policy, having professed themselves satisfied with the assurances that existing arrangements have the sanction of the British War Office. On February 21 a resolution (supported by the opposition) to the effect that all nickel mined in Ontario should be refined wholly within the British Empire and that the Province should own and operate a refining-plant was defeated by a vote of 59 to 26—a strictly party division. The opposition makes a strong point of the light taxation levied by the Government on the operations of the International Nickel Co., under the agreement, made some time since, for a flat rate of $40,000 per year, which it is contended is many times too low, in view of the great expansion of the company's business caused by the War. The Government has promised a revision of its arrangement, but when challenged as to its policy replies that it will be guided by the long-delayed report of the Nickel Commission, the appearance of which has been retarded by the illness of the chairman, G. T. Holloway. Some surprise was created during a recent debate by the statement of Attorney-General Lucas that at the outset of the War the International company had offered to give the Canadian Government the entire control of its output, which is regarded as an effective answer to the accusation that the company is under German influence. Nothing has been heard recently of the project of the British America Nickel Co. for the construction of a refinery, but it is understood that they are experiencing some difficulty in selecting a suitable site where they can obtain the large supply of electricity that they will require. Owing to industrial expansion, more especially as regards the manufacturing of munitions, the demands of the localities served by the Provincial Hydro-Electric Commission with power generated at Niagara Falls have so greatly increased that extensive additions to the system are being undertaken, and in the meantime the plans of the British America company will, as a consequence, be held in abeyance.

The first annual report of the Hollinger Consolidated shows a production of $5,073,401, the number of tons hoisted being 604,062. Profits from the operations were $2,866,964, and premiums on shares sold $180,000. The net income after deductions for taxes and depreciation was $2,856,409. Dividends amounting to $3,126,000 were paid, leaving a deficit of $269,590. Working-costs were $4.03 per ton as compared with $3.98 in 1915. Additions to plant and development cost $599,417. Actual ore reserves on December 31 were estimated at $34,185,535 as compared with $33,837,870 at the end of 1915. The four-weekly statement for the period ended January 28 showed a further increase of the deficit to $298,490. The gross profits were $217,000 from the treatment of 48,119 tons of ore of the average value of $8.71 per ton, at a working-cost of $3.88 per ton. The mill ran 85.5% of the possible running-time.

The Dome Mines during February produced bullion to the amount of approximately $172,000 from the treatment of 36,400 tons of ore of the average value of $4.75 per ton at a cost of $2.88 per ton. The new Hardinge ball-mill now in course of installation is expected to be complete in a few weeks, bringing up the tonnage to about 55,000 per month. Production at this mine, as elsewhere, has been much curtailed by the labor shortage. It is understood that the forthcoming annual report will show that development at depth has much improved the average grade of the ore. Electric power has replaced steam at the West Dome Consolidated and has been found much more economical. Driving on the main vein for a distance of 500 ft. on the 300-ft. level shows that the average width of five feet is maintained. Assays show considerable variation, but the average gold content for the whole width of the vein is $12 per ton.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ARIZONA

Gila County

(Special Correspondence.)—The Christmas mine, at Christmas, is the property of the Gila Copper Sulphide Co., and not of the American Smelting & Refining Co., as stated in the issue of the Mining and Scientific Press of February 24. Moreover, the tonnage capacity per hour of the aerial tramway at this mine was also under-rated.

Christmas, March 9.

Mojave County

(Special Correspondence.)—Oatman. Shipments of bullion were made the first week of March from the Tom Reed and the United Eastern mines. The amount of the Tom Reed shipment was not given out but is unofficially reported to have been $60,000, for the month of February. The United Eastern shipment contained approximately 5800 oz., troy, valued at about $72,000, making a total for February of about $145,000 from this mine.——The Big Jim and Tom Reed have developed the Big Jim-Aztec orebody for approximately 1800 ft. About 400 ft. intervenes between the headings of the two mines on the 400-ft. level with both faces in ore. The average of the Big Jim is $20.67 on the 400-ft. level and $58.60 on the 500-ft. level. The Tom Reed has been in ore for the past 100 ft., said to average $50 a ton. Some very rich specimens have been extracted.——Preliminary flotation-tests on ore from the Gold Ore mine resulted in a concentrate of 30 into 1 with an extraction of 95%. The tests were conducted at the San Francisco laboratory of Minerals Separation Co., Ltd. Further tests are to be conducted.——The fiscal year of the Tom Reed Gold Mines Co. ends March 31. The new management took charge in April, 1916, and has done much development work in the eastern end of the company's property, resulting in opening a large body of ore of good milling grade containing streaks of rich ore. The vein is 30 ft. wide and the entire vein filling is ore of a milling grade. The company is constructing a 150-ton addition to its cyanide-mill. Marcy ball-mills will be used for crushing and pebble ball-mills for fine-grinding.

Oatman, March 14.

Pima County

(Special Correspondence.)—The Ray Hercules Mining Co. is to build a 2000-ton concentration plant at Ray. This property is in the centre of the Ray district and has a large body of ore developed. This ore is an extension of the Ray Consolidated orebody, which was displaced by a fault, with a 350-ft. drop. The original plan was for a mill of 1000 tons daily capacity, but the plans have been enlarged.

Ray, March 14.

(Special Correspondence.)—A strike was made on the Copper King group of the Mile Wide Copper Co., the last week in February where extensive chalcopyrite was encountered at the 200-ft. level. After cross-cutting the orebody at the 200-ft. level 16 ft. and 4 in., the cross-cut was continued 20 ft. farther to a parallel orebody of chalcopyrite. Superintendent Visel states that it will average better than 30% copper. Development to date shows it to be 8 ft. wide. As far as developed it has no connection with the previously developed orebodies, being a parallel vein. It is the opinion of the management that the new strike will ultimately join the 16-ft. vein being developed since last December.

Tucson, March 12.

Santa Cruz County

Nogales. A. C. Mowbray and A. C. Wright have taken a bond and lease on the Rosario mines in the Santa Rita mountains, not far from the Salero property. There is a 6 ft. vein developed by an adit, from which there has been taken a great deal of good ore. Some of the samples ran 51% lead, with a good showing in silver. Other samples showed a high percentage of zinc.

Near the upper end of the Montosa canyon, in the Santa Rita mountains, on the west side, the Santa Cruz-Bisbee Co., J. L. Walker, manager, is reported to have made recently a strike of high-grade ore, at the end of a 300-ft. tunnel, which has cross-cut a ledge 10 ft. wide, with ore yielding lead, zinc, gold, and silver. The vein was cut at a depth of 300 ft. below the croppings. Another tunnel is being driven, and it will go 1000 ft. before reaching the vein which it will cut much lower.

Yavapai County

Prescott. At the Mint mine, three miles west from Copper Basin, the shaft is 200 ft. in depth, and the timbering is being re-placed. This part of the work will soon be completed. In the meantime the engine is being placed upon a new concrete foundation. The first new work will be the driving of a 100 ft. cross-cut at a depth of 200 ft. Work done some years ago, when the Mint was classified as a gold mine, showed the existence of copper ore of good grade, and the cross-cut will be run with a view to determining the extent of the copper ore.

The camp in Copper Basin of the Arizona-Portland Mining Co. is now thoroughly equipped with modern appliances for shaft sinking, and the sinking of the shaft to at least 500 ft. will go forward rapidly. A new hoist, compressor, pump, three jack-hammers, and a dreadnaught, with all minor appliances, are now at the mine and in a few days will be ready for work. The shaft is 140 ft. deep.

Plans are being made to resume operations at the Tuscumbia mine, in the Crown King district, and owned by the Tuscumbia Mining & Milling Co. of Arizona, and has a production record of approximately $500,000, the ore is coming from four adits to a depth of 300 ft., and in the shoots carrying as high as 1000 oz. silver to the ton. The property is under option to a Nevada and Californian mining and oil man. Work will begin April 1, contingent upon the state of the roads and weather at that time.

Geological and mineralogical conditions suggest that the orebody recently discovered at shallow depth in the Calumet & Jerome workings is a continuation of the deposit encountered at a similar depth in the United Verde extension workings during the early stage of development there. The ore was opened in Calumet & Jerome ground near the line of the United Verde Extension property and is identical in appearance with the ore exposed in the upper workings of the last mentioned. It samples as high as 12% copper and carries an average copper content of 4 per cent.

The Foreshoulder group of claims has been purchased by A. B. Rombauer, of Butte, Montana, and others. The acreage is situated in the Walker basin near the Pine Mountain property and has considerable prospective value. The former owner, Jersey McCloud, sunk a shaft 85 ft. and opened a body of gold-silver ore. It was this showing that decided Rombauer to buy the property. The latter will equip the shaft with machinery and will sink it to a depth of 200 ft. before cross-cutting the formation.

The sale of the Foreshoulder group, following so quickly the sale of the old Homestead property to the United States Continental Mines Co., of New York City, has stimulated interest in the mines at Walker basin. Four extensive properties are now being worked there and another will become active the current month.

CALIFORNIA

F. M. Hamilton, State Mineralogist, announces that the first annual report, covering the work of the State Mining Bureau in protecting Californian oil-fields from infiltrating water, has been published and is ready for distribution. There is about $250,000,000 invested in the Californian oil business, and during the past fiscal year about $6,000,000 was expended in drilling new wells, and it is unnecessary to more than call public attention to the insignificantly small amount of money necessary for the protection of the investment. The reports of oil-field work made to the State Mining Bureau for the week ended March 10, 1917, show 18 new wells started, 29 to be inspected for test of water shut-off, 12 deepening or redrilling, and 5 to be abandoned.

Butte County

Oroville. It is reported that numerous transfers of mining property in the eastern part of this county near Forbestown, and also some mines in Plumas county, near La Porte, have recently been taken under option by Eastern men, who propose to develop them and equip them with machinery. The properties referred to are mostly low-grade, with a great deal of ore available.

C. L. Salmon has bonded his quartz mine at Badger Hill, a mile from Cherokee, to the California Extraction Co. Kay & Elliott are members of the company and they have other mining interests in this county. Last summer they erected a plant to work a portion of the bottom of the South Yuba river, above Edwards crossing. The Salmon mine has a shaft 100 ft. deep on the vein and some fine ore was extracted when the property was operated by the Salmon brothers. Included in the surface equipment is a 4-stamp mill, which was in operation a few years ago. The bonding company will start active work of development in 60 days, or as soon as the roads are in shape for hauling in supplies.

El Dorado County

Placerville. Frank Everett has bought the Cambrian mine near Coloma, and will begin the work of development.

Nevada County

Nevada City. The lower levels of the Champion-Providence mines are flooded because of the breaking of the large electrically driven pump that handles the water in those mines. The pump can only be repaired by a new casting, which will be provided as soon as practicable. Meanwhile, work will be continued above the 2700-ft. level. It is thought the pump will be in working condition again before the water reaches the 2700-ft. level.——The work on the addition to the Golden Center mill is nearly completed. All the machinery is in position and it is thought by the first of next week the ten new stamps will be pounding away daily. Manager Charles Brockington stated last night that the work only awaits the arrival of the concentrator belts and then the mill will be started immediately.——What is believed to be one of the most important strikes made in the Grass Valley-Nevada City district for a number of years is reported in the Pittsburg mine at Gold Flat, near Nevada City. While running a long drift at 1300 ft. depth, quartz was struck which is believed to be the long-sought Gold Flat-Potosi vein, which yielded several fortunes in former days and at less depth. The ore is not free milling, making it necessary to ship to smelters for treatment.

Washington. It in reported that the Eagle Bird mine, an old producer, six miles east of Washington, is to be re-opened. William Wilson of Marysville is the owner and he has interested capital in re-developing the property. A new mill and blacksmith shop have been erected.

Plumas County

(Special Correspondence.)—Grading of the Indian Valley railroad has been completed to the lower camp at the Engels mine, and rails are laid to three miles beyond Vermont. Heavy snow is hampering work but the company expects to be in a position to handle ore and freight between Keddie and the mine by April 15.

The Spreckles interests of San Francisco have acquired control of the Engels mine and are preparing for more extensive work. John Reinmiller has been appointed general manager, and grading for the two new flotation-units is progressing. Each unit will have a capacity of 500 tons daily, and the first is scheduled to be ready by July 1.

The U. S. Smelting, Refining & Mining Co. has placed a compressor at the Iron Dike mine and has 20 men working. The orebody is stated to be 12 ft. wide and of good grade. In the Five Bears group the orebody is 55 ft. wide and of excellent grade. There are 20 men at work and it is reported 40 more will be added. The company is also working the Eagle Hill and other claims between the Engels and Walker properties.

The United States Exploration Co. is planning the building of a mill and power plant at its property near Granite mountain. A strong vein of gold-bearing quartz has been opened at a depth of 300 ft., according to news from the mine.

Electrically operated pumps and a hoist have been installed at the Crescent gold mines, near Crescent Mills, and a transmission-line built to the property by the Great Western Co. Unwatering of the shaft will start within a few days.

Portola, March 19.

Shasta County

Redding. The Arps group of copper mines near Copper City has been sold. Included in the deal is the Reno group of mines adjoining. The Arps group was owned by R. M. Saeltzer and Antone Jaegel of Redding and William Arps of Copper City. Arps located the mines and spent years in developing them. Joseph Kahny of Redding also owned an interest. The purchasers are San Francisco and Oakland men who have formed a corporation known as the Arps Copper company.

The Arps group was bonded last August. The bonders made two shipments of copper-silver ore to the Kennett smelter. The returns were so satisfactory, they concluded to pay the money and take the group. Sixteen men are at work in the Arps mines. Superintendent Henry says the company plans to put up some sort of reduction works—a flotation plant, perhaps, but that at present ore will be shipped to the smelter.

The newly financed Afterthought Copper company is preparing for a heavy output from its mines at Ingot. Repairs to the main adits have been completed and car-tracks and bridges are being overhauled.

The Mammoth Copper Co. has installed an electric hoist and pump at the Donkey copper mine, near Ingot, and has unwatered the shaft and is sinking and driving on a deposit of copper ore.

The Mountain Copper Co. is making the heaviest copper output in its history since the closing of the old Keswick plant. The capacity of the Minnesota flotation-plant has been practically doubled, and a heavily increased output of ore and concentrate is being forwarded to the Martinez smelter.

Arrangements are being made for more vigorous work at the Michigan, Shasta-Belmont and other properties lying near the Bully Hill and Arps groups. The Shasta-Belmont directors are considering the advisability of erecting a small flotation-plant.

Sims. The first carload of chrome from a mine opened near Sims less than a month ago was shipped this week to Cleveland, Ohio.

Twelve men are employed by the American Manganese Co.

on its manganese claims on Duncan creek, west of Ono. Eighteen miles of road will be constructed before ore can be shipped to the smelter at Heroult. Two tunnels are being driven into the orebody.

SIERRA COUNTY

ALLEGHANY. Paul Proper of Oakland, has purchased a one-fourth interest in the Kanaka mining claim, owned by Ambrose Madden. A tunnel has been driven 300 feet.

DOWNIEVILLE. The pay-shoot on the Oro vein at Downieville, was found by driving a cross-cut from the drift to the vein last week. The shoot dips to the north and the gouge on the walls, as well as the crushed quartz, pans free gold. The vein is 4 ft. wide where the shoot was found. A drift will be run to determine the length of the shoot, and subsequently the lower or No. 3 adit will be continued on to the vein, a distance of 150 ft. east, which would give 500 ft. of backs. The property is being developed by Dr. Reynolds and associates of Alameda under a bond, and is now under the charge of John Costa.

Several small snowslides have come down through the Keystone ravine, below Sierra City, says the *Messenger*. The boarding-house of the Keystone mine is said to be smashed and the mill damaged to some extent. The Keystone ravine is noted for its slides and at times everybody moves from the mine.

A contract is to be let to extend the tunnel at the Wide Awake gravel property at least 100 ft. farther toward the channel, and several parties are figuring on putting in bids for the work. The matter will be definitely decided when Thomas Wilson, who has the property under bond, returns.

SISKIYOU COUNTY

Lottie A. Bell of Etna Mills has applied to the State Water Commission for permission to approximate 12½ cu. ft. of water per second from Taylor creek, tributary to the east fork of Salmon river for mining purposes. The details of the proposed works are not given.

TULARE COUNTY

(Special Correspondence.)—The incorporation and property of the California Talc & Soapstone Corporation, which operated for a number of years in Tulare county, but has been inactive for several years owing to lack of raw material, has been taken over by a new company composed of W. A. Saylor and A. T. Wood of Oakdale, and G. W. Brown, George D. Avery, and Omar Avery, of Porterville. The new company has under lease 600 acres about a mile north-east of Porterville, on which there are extensive deposits of talc of a fine grade, much of which has but recently been discovered, some of it by accident, as in the case of the drilling of a well when a mass 100 ft. in depth was discovered. Some of the talc is almost pure, containing less than 0.25% of iron and less than 1% lime. Twenty men will be put to work on the deposits, and the talc will be hauled to the railroad and shipped to the mill at Lindsay, that was formerly operated by the other company, but has been closed for the past several years. Later when the Santa Fe Railroad builds into this community it will run near the property and they have agreed to run a spur-track to a convenient location where a new mill will be built.

Boydston brothers, owners of extensive orange groves in the vicinity of Porterville, now have in operation their new agricultural lime-mill situated on the P. & N. E. railroad, about 5 miles east of Porterville. The mill has a present capacity of 70 tons per day, which with added equipment contemplated, can be raised to 150 tons daily. The latest type of machinery is used throughout the mill. A force of 30 men is employed at the mill and mine, two miles distant. Miners have been at work in the mine for several months taking out sufficient rock to get the plant started. Hitherto all the lime for use in orchards and otherwise has been shipped into central California from the northern and southern parts of the State, so that a lime-mill in the central part of the State will mean a considerable saving in freight to users of lime in that section.

Porterville, March 14.

TUOLUMNE COUNTY

(Special Correspondence.)—The sudden and unexpected suspension of operations at the Dutch-App mine a few days ago has given rise to much speculation in local mining circles. However, the prevailing belief is that work was stopped to enable carrying out the plans lately adopted for extensive changes in the plant, the capacity of which will, by the improvements contemplated, be increased to 18,000 tons of ore per month. W. J. Loring, head of the company, is at present not in the county, and likely not before his return will it be known just what is to be done at the property.

Twenty tons of ore is milled daily at the McCormick mine, north of Jacksonville. Ten men are employed and an assay office has just been erected. The mine is worked through an adit 1500 ft. long.

A steam-hoist, an air-compressor and other machinery purchased from the Street mine, at Tuttletown, are being hauled to the magnesite mine near Chinese Camp that is being operated by Eugene Schmitz and associates, of San Francisco. Buildings to accommodate the working force and machinery are being erected.

Sonora, March 10.

COLORADO

LAKE COUNTY

LEADVILLE. Development in the Down Town section is increasing. This territory which was closed to activity up to two years ago by an enormous flow of water that flooded the greater part of the old workings is now open to operations and is being exploited by six properties, says the *Chronicle*.

At the Penrose, the scene of the pumping that drained the area and where the plant installed continues to handle the water, several large and important ore-shoots have been opened. Enormous bodies of manganese have been uncovered in the upper workings and a steady tonnage of the ore is being extracted. Prospecting drifts that are being driven into new territory on several levels have exposed large bodies of zinc and lead carbonate. Development in these new discoveries is still under way and the extent of the ore deposits has not been ascertained. Trial shipments of the zinc carbonate have been made showing the ore to contain on an average of 25% zinc.

Recently the tonnage from the property has been curtailed by a shortage of railroad cars, a trouble that has been experienced throughout the winter. Because of the inability to secure the necessary cars, no effort is being made at present to increase the production from the property. Contracts for manganese are being filled and the other ores are being held for shipment later when more favorable conditions will prevail.

The pumps continue to throw 1800 gal. of water per minute, which appears to be the normal flow in the Penrose and surrounding territory.

At the Home Extension and Cloud City properties the development of the large manganese bodies that have been opened is progressing and a heavy tonnage of the ore is being produced. Considerable prospecting is also being done which promises to uncover new deposits.

IDAHO

SHOSHONE COUNTY

The Mammoth mill, which has been undergoing extensive changes during the past few months, is now practically a new mill and is running at capacity on ore from the Morning mine. Numerous changes and many additions were made, including a large flotation-plant. The capacity of the mill was also increased from 450 to 500 tons per day, which added to the capacity of the Morning mill gives a total milling capacity

of 2000 tons per day. The Mammoth mill is now one of the most modern and complete in the district.

The force at the Jack Waite mine has been increased to 35 men, and an additional team has been put on the road hauling ore, making three teams. Each team hauls from 4 to 5 tons at a load. The distance hauled is 10 miles and last month snowslides seriously interfered with hauling. The mine is reported in fine condition, and shipments are netting the company a substantial surplus after paying all operating expenses which will be sufficient, it is expected, to build a mill as soon as the snow will permit outside work.

MICHIGAN

Houghton County

CALUMET. This is going to be a year of enormous construction work among the copper mining companies of this region and millions will be spent in the erection of new plants, additions and auxiliaries to old plants, and in the extension of mining and milling work in every direction says the *Boston News Bureau*. The Calumet & Hecla and its subsidiary companies will lead in these enormous expenditures.

Structural work is to be carried on at the Isle Royale, Ahmeek, and other subsidiary mines, at the big reduction and copper extraction plants of the Calumet & Hecla at Lake Linden, Hubbell and elsewhere. A dozen or more of the mining companies will erect scores of new residences and boarding houses for their employees, as well as clubhouses and social centres. Concrete and steel will enter into the new construction work this year on a scale never before attempted.

One of the biggest pieces of work to be undertaken by Calumet & Hecla will be the erection of the large new coal-derricks or aerial tramways at Hubbell, where the big supplies of Calumet & Hecla fuel are received. Two bridges, capable of handling 21 tons of coal per minute from boat to dock, will be put up. The largest coal carrier can be unloaded through use of these bridges, in six to eight hours, thus gaining considerable time in a single season in getting back down the lakes after new cargoes.

The Calumet & Hecla and associated corporations also this year will lay in the greatest supplies of fuel ever brought to the district, probably something over a million tons. The Hubbell docks are to have a capacity of 500,000 tons, in addition to 300,000 tons at the Dollar Bay docks, the big capacity of the Isle Royale fuel yards, and the Point Mills plants. At present enormous consignments of coal are coming in by rail from Milwaukee and other points.

The Isle Royale Mining Co. will this summer erect four modern changing-houses, each 42 by 96 ft. They will be of steel frame construction with concrete walls and fireproof roofs. The company is now erecting a temporary wooden rock-house at No. 7 shaft.

HOUGHTON. The annual report of the Osceola Copper Co. shows that the cost of producing copper in 1916 was 11.69c. per pound, which was an increase of 16% over the cost in 1915. The recovery of copper per ton of rock in 1916 showed a slight improvement and amounted to 15.2 lb. Notwithstanding this comparatively low yield, the company succeeded, as above stated, in showing earnings of almost $29 per share, in spite of all the increased costs of doing business. It was an achievement which bears striking testimony to the manner in which the low capitalized properties of Lake Superior are able rapidly to increase share earnings on a high metal market.

It has been reported at the office of the Mass Consolidated Mining Co. that the Evergreen lode has been struck on the 7th level, 360 ft. from the Butler lode and that the strike looks rich. The company has just sold a lot of copper for nearby delivery at 36½c. per lb. cash.

The Calumet & Hecla runs its No. 2 re-grinding mill, which handles the sand or tailing dredged from the Lake, on Sundays from noon on. This might be called a gold mine says the *Keweenaw Miner*, as the copper recovered here that is being sold for over 30c. only costs a little over 4c., and then there is more copper recovered from the slime at the leaching-plant. The dredge has not lost a minute during the whole winter by reason of being blocked by ice, as a special small gang devotes its time to this work.

MONTANA

Silverbow County

The pay-roll of the Butte district, including miners, clerical help, public service corporation's employees, and others, for the month of February amounted to $3,500,000. The Anaconda Copper Mining Co. for its clerical force alone had a pay-roll of $41,830 for February, which was the shortest month of the year. When this is added to the $1,596,352 paid to the miners, it means that the Anaconda Copper Mining Co.'s pay-roll for the shortest month of the year will total $1,638,182 for Butte alone.

In addition to the figures the following were obtained as the pay-roll for February: East Butte Copper Mining Co., $146,700; Elm Orlu Mining Co., $50,000; Timber Butte Mining Co., $25,000; Butte-Ballaklava Copper Co., $7014.

It is estimated that the public service corporations, the corporations other than mining and the business houses paid out approximately $1,000,000 in wages for last month, which will make the total pay-roll for Butte amount to $3,500,000.

When one considers that Butte has at present a population of 110,000, it means that the mines alone pay what amounts to an average of about $24 a month for every man, woman and child in the mining city.

There are few cities of three and four times the population of Butte which have a pay-roll of such magnitude, and when one considers that the wages paid at present are $4.75 a day of eight hours and that most of the money received in wages is spent in the city, there is little surprise at the class of goods which the residents of this city demand and which the merchants of Butte carry in stock.

NEVADA

Nye County

MANHATTAN. Manhattan district is attracting renewed interest by reason of the rich development in the White Caps mine, just below the town of Manhattan. Concerning this the *Tonopah Times* says: The east drift on the orebody at the 425-ft. level in the White Caps is now out 50 ft. and a cross-cut has been started south in the face of this drift. This cross-cut is now in 6 ft. and is to be extended to the hanging wall. The management expects to resume operations in the south drift. A drift has already been started from the cross-cut. A grab sample from the first round of shots returned an assay of $76.40 per ton.

It is expected that the west orebody will be encountered in the west cross-cut in about two weeks. Two cars of machinery are now in Tonopah awaiting shipment to Manhattan. One part, weighing 13 tons, will be taken over as soon as the roads will permit of heavy hauling again. A 16-horse team will be required to haul this part to the mine. Four more cars of equipment for the mill are expected to arrive here this week. This will complete the shipment for milling purposes, the arrival of which was delayed for several weeks.

NEW MEXICO

Grant County

(Special Correspondence.)—Perry Crawford is mining a large quantity of manganese from his property, a city lot at Silver City, and shipping the ore to Denver.——The Grant Copper Co. will place machinery for the development of a mine it owns near Silver City. Roy H. Jones, of El Paso, Texas, is interested.——The Hanover Bessemer Iron & Copper Co. at Hanover, will re-build its milling and power-plant that was recently destroyed by fire, involving a loss of $100,000.

Silver City, March 13.

QUAY COUNTY

TUCUMCARI. The discovery of tin in the ores of the Red Peaks Copper Co.'s mine is announced by D. E. Thomas, the superintendent. These mines are near Tucumcari, in the eastern part of the State.

SOCORRO COUNTY

(Special Correspondence.)—W. Rowland Cox, consulting engineer for Socorro Mining & Milling Co., made a brief visit of inspection of the company's properties the past week. For the last half of February, the plant produced 13 bars of gold and silver bullion.——At the Pacific mine, development is being pushed on two of the lower levels. The greater part of the old ore dump, accumulated during the past five years, has been transported to the terminal of the aerial tramway and hauled by the latter to the Socorro's mill for treatment.

The Mogollon Mines Co., operating the Last Chance mine, shipped 13 bars gold and silver bullion and several tons of concentrate for the latter half of February.——The Oaks company is doing development work on the Eberle, Clifton, and Maud S. properties, a contiguous group which, from both a geographical and geological view-point, promises to be one of the most important factors in the immediate future operations of the district.

Developments on the Bearup group north of Cooney are encouraging, with 3 ft. of mill-ore in the face of the tunnel now in 70 ft.——On the Mitchell group, in the same part of the district, a cross-cut tunnel has encountered 2 ft. of mill-ore.——Driving continues in the main adit of the Gold Dust properties in the southern part of the camp. The heading is expected soon to cut the orebody opened in the upper levels.——The best driving record for this district was recently made at the Last Chance mine by the Mogollon Mines Co., when the 900-ft. level was advanced 12 ft. in 24 hours.——The Oaks company has started work on the Maud S. mine.

Mogollon, March 6.

UTAH

TOOELE COUNTY

FERBER. There is a new town on the map in Utah—Ferber. A short time ago Ferber existed merely as a town-plot on paper. Today, according to the *Salt Lake Tribune*, Ferber is a real town with a boarding-house which accommodates 40 men; two portable houses, and a number of framed tents. It has one distinctive advantage—it is easy of access. A daily auto-stage and mail-service from Wendover to Ferber has already been established by Stroat brothers, the 40 miles between the two points being covered with regularity and without difficulty. Ferber will probably be the principal town of the Deep Creek mining region for some time to come. The recent completion of the railroad into the district has given a decided impetus to mining throughout the Deep Creek region.

MEXICO

A renewal of mining and smelting operations in northern Mexico is becoming general.

American Smelting & Refining Co.'s large smelter at Monterrey recently re-opened. Simon Guggenheim and Edgar Newhouse, with C. L. Baker, general manager of the company's southern department, are arranging for re-opening the Matehuala smelter in the State of San Luis Potosi.

The company plans to operate its own trains between Laredo, Texas, and Monterrey, for transportation of coke and other supplies, and to carry bullion from the smelter to the border. The de facto government has promised to exercise unusual vigilance in keeping the railroad open so that smelter operations will not be hampered.

Mazapil Copper & Mining Co., composed of American interests, has resumed operation of its smelter and mines at Concepcion del Oro, in the State of Zacatecas.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

JOHN P. MILLIKEN, of Colorado Springs, is here.

L. P. SHACKELFORD is returning from Washington to Juneau, Alaska.

JOHN REINMILLER is now general manager of the Engels copper mine.

C. C. BROADWATER has returned to San Francisco from Park City, Utah.

DONALD F. IRVIN is sailing from New Orleans this month for South America *via* Panama.

CHARLES E. VAN BARNEVELD, of the U. S. Bureau of Mines, was in San Francisco last week.

L. N. B. BULLUCK, formerly at Mexico City, has been promoted to major in the Canadian Engineers.

ARTHUR H. COLLBRAN sailed from San Francisco on March 20 on his way to Yokohama and thence to Korea.

ALF WELHAVEN, general manager for the Oriental Consolidated Mining Co., at Unsan, Korea, was in San Francisco.

MAURICE CLARK, representing the Exploration Company of New York, is in Calaveras county, California, and will go to Oregon shortly.

W. J. GRUSS has resigned as mill-superintendent for the Engels Copper M. Co. and is now in San Francisco. He will soon leave for Arizona.

H. H. NICHOLSON has made an examination of the Black Bear mine at Grass Valley, and has returned to the Plinco mine at Doyle, California.

HENRY C. CARLISLE has been appointed superintendent for the Mandy Mining Co., a subsidiary of the Tonopah Mining Co. of Nevada, with headquarters at The Pas, Manitoba, Canada.

ARTHUR E. WELLS, in charge of the Salt Lake station of the U. S. Bureau of Mines, is inspecting the Cottrell plants in company with W. C. CAPRON and J. K. MURPHY of the Anaconda company.

THOMAS VARLEY, metallurgist for the Federal Lead Co. at Flat River, Missouri, for the past five years, has resigned to accept the same position with the U. S. Bureau of Mines at the new station at Moscow, Idaho, to be established in connection with the University of Idaho.

Obituary

MARK B. KERR died at his home in Berkeley, California, on March 15, at the age of 59. He returned very ill from Salvador a few days before. He was an engineer of wide experience and high character. Early in his career he worked on the topographic branch of the U. S. Geological Survey and during later years he was connected professionally as manager or consulting engineer, with a number of well-known mines, such as the W. Y. O. D. at Grass Valley, the Paloma in Calaveras county, the Jumper, in Tuolumne, and the Montana Tonopah and West End, at Tonopah, Nevada.

A TOPOGRAPHIC MAP of Washington, D. C., and vicinity by the United States Geological Survey is now ready for distribution. The new map is the result of recently completed topographic surveys, and is a typical example of the best art of map-making as refined and developed by the Geological Survey. The map was drawn in the field by the topographic engineers of the Survey. It shows an area of 465 square miles, including almost every form of topography, from the lowlands along the Potomac Drive to the broken country in Rock Creek Park and the picturesque gorge of the Potomac above the city. It is sold by the Geological Survey at 25c. per copy.

THE METAL MARKET

METAL PRICES

San Francisco, March 20

Antimony, cents per pound	24
Electrolytic copper, cents per pound	38
Pig lead, cents per pound	9.50—10.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$115
Spelter, cents per pound	13
Tin, cents per pound	50
Zinc-dust, cents per pound	18—20

ORE PRICES

San Francisco, March 20

Antimony, 50% metal, per unit	$2.00
Chrome, 40% and over, f.o.b. cars California, per ton	18.00—20.00
Magnesite, crude, per ton	8.00—10.00
Tungsten, 60% WO_3, per unit	17.00—17.50
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 50% (under 35% metal not desired)	29.00

Manganese ore, 40 to 45%, sells f.o.b. Chicago at 58c. per unit with a penalty of 50c. per unit for more than 8% silica.

EASTERN METAL MARKET

(By wire from New York)

March 20.—Copper is dull and easier. Spot lead is lower, at 9.75 to 10c., the market conditions remain practically unchanged. Zinc is lower, with a stagnant market.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
Mch.	14	73.25	Feb. 6	76.79
"	15	73.00	" 13	77.62
"	16	73.00	" 20	78.41
"	17	73.00	" 27	77.37
"	18 Sunday		Mch. 6	76.50
"	19	72.87	" 13	75.06
"	20	72.37	" 20	72.91

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	....	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
Mch.	14	9.75	Feb. 6	8.41
"	15	9.75	" 13	8.60
"	16	9.75	" 20	9.58
"	17	9.75	" 27	9.45
"	18 Sunday		Mch. 6	11.54
"	19	9.75	" 13	9.50
"	20	9.75	" 20	9.75

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	....	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
Mch.	14	36.00	Feb. 6	33.00
"	15	36.00	" 13	33.90
"	16	36.00	" 20	35.37
"	17	35.75	" 27	36.00
"	18 Sunday		Mch. 6	36.29
"	19	35.75	" 13	36.25
"	20	35.75	" 20	35.87

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	....	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

The Old Dominion Copper Co. has declared a quarterly dividend of $3 per share, payable March 30 to stock of record March 14.

Old Dominion paid $3.50 three months and $3 six months ago.

Since 1905 Old Dominion has paid dividends aggregating $40 per share.

The Old Dominion Company of New Jersey declared a dividend of $3.50 and the United Globe Mines a dividend of $22 per share.

Value of 1361 tons of concentrate resulting from flotation operations during February at the Miami Copper Co. plant was $265,766, against $318,628 derived from production of 1553 tons of concentrates in January.

A comparison of the monthly statements which Miami makes in connection with its flotation operations follows:

	Feb.	Jan.	Dec.
Tons feed	113,639	124,676	121,493
Tons concentrates	1,361	1,553	1,480
Assay:	%	%	%
Copper in feed	1.180	1.175	1.118
Copper in concentrate	43.426	43.059	41.531
Copper in tailing	0.668	0.646	0.620

Not for another month do Miami interests look for a decision from the United States Circuit Court of Appeals on the company's recent appeal from decision of the United States District Court in the suit brought against it by Minerals Separation company.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date		Average week ending	
Mch.	14	10.75	Feb. 6	10.06
"	15	10.75	" 13	10.52
"	16	10.67	" 20	10.54
"	17	10.67	" 27	10.70
"	18 Sunday		Mch. 6	10.85
"	19	10.67	" 13	10.87
"	20	10.67	" 20	10.69

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	....	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date			Mch.	6	115.00
Feb.	20	140.00	"	13	105.00
"	27	135.00	"	20	115.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	....	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38 37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	....	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

ALUMINUM

Quotations remain unchanged at 57 to 59c. for No. 1 virgin aluminum, 98 to 99% pure. The market is quiet.

ANTIMONY

The spot market continues quiet at 31c. per lb., nominal, for Chinese and Japanese goods. Spot metal is very difficult to obtain, however. As high as 32c. was asked yesterday. Sellers seem anxious to come to an understanding with buyers as to future deliveries even to the extent of shading. Metal shipped from China and Japan in February is quoted at 18.25c. in bond with March shipments at 15.50c. Sellers are asking about 29c. for delivery in two weeks. If the Government buys ammunition on a large scale as a result of war, prices are expected to advance.

ORES

Tungsten: The market is active with foreign demand the feature. There has been buying by both foreign or domestic consumers with high-class concentrate selling at $17 to $17.50 per unit. A domestic user of ferro-tungsten has recently made a large purchase. The present quotation is about $2 per lb. of contained tungsten

Molybdenum: Ore deliveries are unsatisfactory, which handicaps the producers of ferro-molybdenum. It is stated that wulfenite has been sold at $2 per lb. contained molybdenum. In the opinion of one dealer molybdenite, if readily available, would probably bring the same price per pound of MoS_2 contained.

Antimony: Prices are a little easier at $2 to $2.25 per unit, but shipping conditions from South America make business very difficult.

The demand for spot antimony is still not quite as pressing and prices range nominally 31c. The forward antimony market has become practically stagnant and March-April shipment is quoted at 14⅞ to 15½c. in bond. In needle antimony further business has been done in large quantities at 9¼c. for March-April shipment from the Far East. The conditions of shipment from South America make business in antimony ore almost impossible.

Eastern Metal Market

New York, March 14.

The entire metal market is a waiting one, both buyers and sellers doing as little as possible until conditions become more settled, both external and internal.

Copper was unchanged until yesterday, when it became a little easier and lower.

Zinc is stagnant with very little being sold. In fact the market is abnormal, as it should normally be more active at this season.

Lead was quite a little easier yesterday because of large arrivals from the West.

Anxiety in the tin market has abated considerably so that yesterday it eased off 1c. per lb. for spot metal to 53 cents.

Spot antimony is hard to get at the nominal quotation of 31 to 32 cents.

The pig-iron market continues to go higher and at advances that are from two to four times the usual ranges. Basic iron has sold up to nearly $34, delivered. Foundry irons are generally $1 to $2 higher than a week ago and Bessemer iron for the last half is $1 to $2 above the prices of a week ago. The Steel Corporation's advances in bars, shapes, and plates have been a surprise, since they are larger than expected. In shipbuilding, 24,000 tons of material has been sold very recently for delivery in the last half of 1918 and the first quarter of 1919—truly decidedly forward buying. Ship plates are quoted at 7.50c. per lb. by Eastern plate-mills, with ordinary tank-plates at 6c. The Cunard Line has covered for between 40 and 50 ships to be built in the United States.

COPPER

While there is still talk of large purchases by the Allies for last half, none has been reported. In fact very little buying of any kind has taken place and the market is dull. A strike started late last week at the Laurel Hill refinery of the Nichols Copper Company on Long Island, which is a disturbing factor, no settlement having yet been reached. It is one of the largest producers of copper. Last Friday the Government bought 100 tons of electrolytic copper at 35c. for delivery in Washington on March 15. No Lake copper is apparently being offered since producers are sold up for months to come. As to exports, one authority states that despite blockades almost 1000 tons per month is being sent abroad. Considerable copper, however, has been sunk on lost vessels. An estimate puts the total that has gone to the bottom at more than 67,000,000 lb. since December 1, 1916. The entire market is a drifting one and difficult to gauge. Some business has been done, but it has not been much. The quotation for March delivery is unchanged at 36.25c., New York, at which some sales have been made. April metal has gone at 36c., while electrolytic copper for the last half has gone at 31c., New York. The April quotation stands at 35.50 to 36c., with May at about 35c. and June at 34c. The quotation for third quarter is about 31 to 31.50c. with 30.50c. asked for last quarter. The output of the Anaconda Copper Company for February is reported at 25,000,000 lb., against 22,500,000 lb. in February 1916. All the leading producers show a substantial increase for February, this year, over February a year ago. The quotation in London for spot electrolytic is £151, which is the same as a week ago. The exports to March 13, inclusive, were 12,506 gross tons.

ZINC

The dissatisfaction commented on last week still prevails. The whole market is dull when it should really be active. Stagnation in the spring season is abnormal. There have been no changes in prices since last week, March delivery being quoted yesterday at 10.62½ to 10.75c., St. Louis, with the New York price from 10.87½ to 11c. The April quotation is 10.25 to 10.37½c., with second quarter at 10 to 10.12½c., all St. Louis. Like the rest of the metals, the market is a waiting one. Zinc is plentiful, but the attitude of both buyers and sellers is to wait until it is definitely known what the foreign and domestic situations are to be. The spot market is little easier if anything, at 10 to 10.25c., but no large amounts are offered and buyers are not many. The present equipment of the Anaconda Copper Company's new zinc-mill is said to have a capacity of 60,000,000 to 65,000,000 lb. of electrolytic zinc per year, with a capacity later of 100,000,000 lb. per year. The London quotation for spot was £47 yesterday, unchanged from last week. Sheet zinc is unchanged at 21c. f.o.b. mill carload lots, 8% off for cash.

LEAD

Delayed shipments from the West have commenced to come in at this market in large quantities since Saturday. Previous to this more or less anxiety prevailed, so that spot metal was selling as high as 11 to 11.50c. The entire situation is so much easier that there is less anxiety all around and spot sold yesterday as low as 10c., New York. Sellers are in reality putting out feelers for business. The American Smelting & Refining Company's price is still 9c. for spot. In general the market last week was quiet. The explanation for the decided change is the fact that the railroad freight congestion has become very much better. It is not at all unlikely that in the near future the present premiums which the independents have been securing over the American Smelting & Refining Co.'s price may be completely wiped out. Lead for March delivery is quoted at 9.50 to 9.75c. with April metal at 9.25c. and May at about 9c. Re-sale lead was offered and sold at St. Louis at 9.75c. Late last week demand for April was larger than for March. The demand for spot lead has fallen off. London's quotation for spot lead is the same as a week ago at £30 10s. The exports thus far for the month have been only 13 tons.

TIN

Two developments the past week have had a marked influence on the market. One is the announcement by the American Smelting & Refining Company that it is now turning out, at its new electrolytic-tin plant at Perth Amboy, New Jersey, 600 tons per month from Bolivian ores and that after July 1, 1917, the output will reach 1500 tons per month or 18,000 tons per year. The other development is the threatened railroad strike. Both of these factors have tended to decidedly ease the market so that spot metal which was selling a week ago at 54c. sold yesterday at 53c. with more sellers than buyers. The strike possibility tends to cause holders of tin to turn it into money, since a strike would only tie up the tin. Some doubt is expressed as to whether the tin output of the new plant referred to will reach the proportion mentioned. This is based on the question as to whether sufficient Bolivian ores can be secured and whether the British interests will allow all this ore to fall into American hands. Anxiety as to the loss of tin from the submarine danger is abating quite perceptibly. It is pointed out that no tin-laden ship has yet gone down. In fact the whole tin market is regarded as having been remarkably fortunate since the war started. Late last week less than 100 tons was sold in a stagnant market. Early this week sales of about 100 tons were made at 47c., mostly Eastern shipment. About 100 tons went yesterday at 53c., due to the pressure on the market. The quantity of tin reported afloat is 3816 tons, with the arrivals so far this month at 1415 tons.

ALUMINUM

The market is entirely nominal and unchanged at 58 to 60c. per lb. for No. 1 virgin aluminum, 98 to 99% pure.

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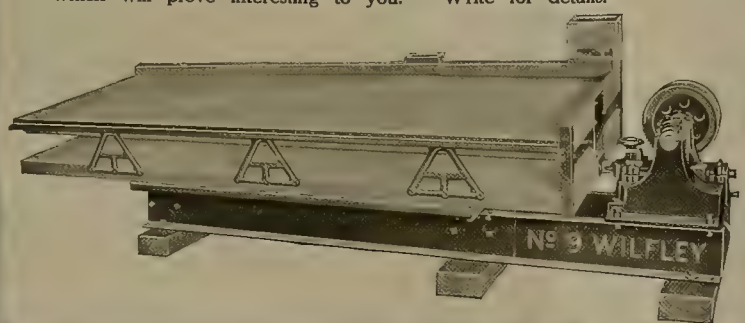

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EDITORIAL

T. A. RICKARD, Editor

PATRIOTISM marks the action of a group of leading copper producers in selling to the Government 45,000,000 pounds of copper at 16.6739 cents per pound, delivery to be completed in four quarterly installments. We understand that the offer was voluntary, and it presages a general readjustment of prices, in anticipation of wise industrial regulation in the national interest.

AMONG the signs of the times it is pleasant to record the offers made by manufacturers to supply the Government either at no profit or at a minimum. From the chairman of the United States Steel Corporation down to the heads of small concerns the willingness is expressed to operate on the national account under Government supervision as to prices, the companies to receive not more than 10% over the vouchered cost.

LEADVILLE is to the front with a discovery of lead carbonate reminiscent of the early days, as will be seen by reference to the letter from our local correspondent. In the Silver King mine, on Yankee hill, a body of lead carbonate rich in silver chloride has been uncovered. During recent years most of the ore mined in the Leadville district has been sulphide, except for the zinc carbonate and silicate ores, so that the finding of another old-fashioned body of oxidized lead ore is more than interesting. Yankee hill is just east of Fryer hill, a locality once famous for rich mines, among which we may recall the Little Pittsburg, Robert E. Lee, Matchless, and Chrysolite.

TIN and tungsten deposits in the Black Hills of South Dakota are described in an interesting manner by Mr. John Bland in this issue. Incidentally he refers to a mill built by Fraser & Chalmers a quarter of a century ago that required little more than a thorough cleaning to be made ready for a new campaign. This is a tribute to the splendid workmanship of those master-builders at Chicago who played so unique a part in the development of American metal mines. They did their work well. Our compliments to the surviving member of the firm, Mr. W. J. Chalmers, whose youthfulness of spirit laughs at Anno Domini and links us with a pioneer epoch in Western mining.

DISCUSSION this week begins with a protest, made by Mr. Horace Stanton, against a railroad company's embargo on the carriage of mine-samples as baggage. We can understand the engineer's desire to take his samples with him and suggest that Mr. Stanton discuss the matter with the responsible official. Mr. Storms replies to the request, appearing in one of our recent issues, for information concerning the effects of faulting on the distribution of rich ore. He gives several interesting examples that should prove instructive. Our friend Mr. F. H. Mason expresses doubt concerning a suggested method for socketing a wire-rope. We shall welcome a reply to his criticism.

STRUGGLE for mastery in the zinc world has become an interesting feature of recent metallurgic history. The Anaconda quite frankly assumes a position indicative of intention to play a leading part. Its activities are noticed in various quarters, where it is investigating other sources of supply. Butte & Superior is expanding into new fields, in spite of a potential production so great that it bears the reputation among informed metallurgists of being the greatest zinc orebody known today. It is estimated that by the end of this year the output of zinc from the mines at Butte will be at the rate of 30,000,000 pounds per month. This is nearly equal to the present copper production from that district. For many years the Butte & Superior regarded the zinc in its ores as a detriment and employed the skill of the ore-dresser to get rid of the obnoxious blende. Thousands of tons of jig tailing assaying 8% zinc were hauled from the mill-dump and used as ballast on the Great Northern railway. Though rather shallow the permanent way of that railroad is the longest zinc deposit in the world. Whatever may happen in the re-alignment of influences with the Anaconda, the Butte & Superior, the Elm Orlu, and the United States Steel entering the lists, it may be taken as certain that the ancient armed peace between the Matthiessen-Hegeler-Heckscher-Wetherill interests, parceling out a helpless American zinc vassalage between them, is destroyed, and a new map must presently be drawn.

READERS familiar with the number 835,120, signifying the basic patent of the Minerals Separation company, will be glad to read the story of the alleged discovery underlying that famous patent, even if the story comes from a domestic source, namely, the brief presented by the company's counsel in the Miami case during the recent appeal at Philadelphia. We do not regard this as a historical account, but it is interesting as the version put forward by the patentees themselves. The psychology of 835,120 is obscure, and is likely to remain so. Messrs. Sulman, Picard, and Ballot allege that they stumbled upon their discovery by ringing the changes on the proportions of oil used in the Cattermole sinking process, although a short time previous to the discovery they had bought Froment's patent and had been instructed by him how to use bubbles for floating

sulphide minerals. They say that they were led to froth-flotation by way of the sinking 'granule' of Cattermole instead of receiving the necessary hint from the rising 'spherule' of Froment. All that can be said is that if they did so, they missed a logical inference and fell into an illogical success. However, it is well to place this story of the discovery on record where it will be read by those engaged in flotation, for the obscurity clinging to the birth of the Minerals Separation company's frothing method has been a factor in confusing the decisions of the courts—decisions that will be more numerous before the great litigation is ended.

CONSTITUTIONAL law has grown apace. The Supreme Court has recorded an addition to the confirmed powers of Congress. The country will feel relieved, for uncertainty as to how far legislation may go in matters vital to the welfare of the nation militates against peace, efficiency, and competency. The railroads have been stripped of more of their pretended rights, so that their position has become increasingly differentiated from that of private owners; in fact, they are public-utility servants, entrusted with the operation of what is neither more nor less than an arm of Government, and the recognition of this status has now been given renewed emphasis. On the other hand, the unions of railroad employees have also been further democratized by the decision on the Adamson law. They are shorn of the privilege to use the strike as a weapon of protest. Interference with the railroad service now becomes interference with the regulative machinery of the Federal government. Thus it appears that the public has gained security in the maintenance of traffic through the quarrel between the operatives and the operators of inter-State systems of transportation. Justice McReynolds, though dissenting from the majority opinion, has neatly summarized the points that must now be recognized as part of our organic law. He says: "it follows that Congress has power to fix a maximum as well as a minimum wage for trainmen; to require compulsory arbitration of labor disputes which may seriously and directly jeopardize the movement of inter-State traffic; and to take measures effectively to protect the free flow of such commerce against any combination, whether of operatives, owners, or strangers." A pleasing circumstance in the closing of this hotly debated incident has been the prior agreement, between the parties directly in contest, to lay aside their differences and compromise upon a plan in conformity with the Act just sustained by the Supreme Court. That will promote a spirit of fellowship and tend to eliminate mutual suspicion and hard feeling, which makes for better service. Still more gratifying is the fact that the harmonious adjustment, reached in conference before the Supreme Court decision had been handed down, was the result of a frank recognition by the train-men and the managers of patriotic duty at a period of national crisis. The episode terminates in a triumph of democratic good sense that goes far to expiate the evil counsels through which the Adamson law was forced into being. In the end it marks a step forward in good citizenship and good government. Although but three branches of the railroad service were originally involved it would appear that the Adamson law makes no discrimination. It undoubtedly applies, as its text declares, to "all employees who are now or may hereafter be employed by any common carrier or railroad." This would effectually dispose of the assumption, hastily made in some quarters, that privileged classes of labor had been set apart by the Act for exclusive enjoyment of its benefits. Contention over so plain a matter would be out of keeping not only with the language of the statute but with the commendable spirit displayed by the managers in meeting the views of the railway operatives.

The Search for Ore

In this issue we publish, with slight abbreviation, a paper on the exploration of metalliferous deposits written by Mr. W. H. Emmons, formerly of the U. S. Geological Survey and now Professor of Geology in the University of Minnesota. The subject is one of such immediate interest to the miner and one concerning which so little is written that we feel sure that our readers will be glad to have it placed before them. Mr. Emmons makes the useful observation that outcrops are generally depleted of their copper in base-leveled areas. Closer study should be given to many districts that have been passed as unpromising under the older standards of exploratory work. The recognition of the fact that an outcrop characterized by abundant sericite, kaolinized material, and chalcedonic quartz is quite as significant as the iron gossan, generally sought as an indicator of copper, is also important. The 'iron hat' is by no means a reliable guide. Sometimes the ore may be found underneath the hat, but as often the miner finds that weathering has left nothing worth while. Neither is the sericitized outcrop infallible, but a clearer understanding of its relation to copper deposits is much to be desired. It might have been well for Mr. Emmons to have called attention to the possibility of paragonite being developed along with kaolin and chalcedonic quartz under conditions similar, except for the presence of soda-feldspars in place of orthoclase or except for the circumstance that potash had not been introduced by the solutions responsible for the hydro-thermal changes. Considering that copper is so commonly an associate of sub-silicic rocks, in which potash minerals are largely wanting, it becomes worth while to investigate the relations of paragonite, this sodic analogue to sericite, for it might easily escape identification in the field.

We venture to take issue with Mr. Emmons in regard to tungsten. Only in a special environment may this metal be classed as one that dissolves slowly. Mr. Emmons might have thrown light upon the fact, now becoming widely observed, that tungsten is a common accompaniment of gold. The ore in many gold mines proves to contain tungsten, sometimes in quantity sufficient to admit of economic separation. The frequency

of this association arouses suspicion that the failure to note its presence may be due largely to inadvertence. Tungsten is found in a large number of the Californian gold mines; it is now known to be common in those of Colorado; it went long unrecognized at the Homestake, but today it constitutes part of the steady production from that great mine. Tungsten has also been identified in recent years as a persistent associate of copper ores, particularly in deposits formed at a high temperature, such as the great orebody of the Moctezuma Copper Company near Nacozari, Sonora. A study of the relations of tungsten to the other metals in these deposits would probably lead to new data concerning their origin. Wherever intense kaolinization has been in progress, a phenomenon so characteristic of a large proportion of the important orebodies of the world, alkaline solvents for tungsten are specially abundant. In the presence of potassium compounds wolframite is readily dissolved, forming a complex series of alkaline tungstates, all of which are highly soluble. In tungsten-bearing silicious dikes, which generally contain considerable orthoclase, subsequent faulting is common, as a result of which kaolinization has become pronounced, thereby leaching the tungsten, and frequently leaving limonite casts of the original wolframite crystals. Furthermore, nearly all wolframite contains minute quantities of disseminated pyrite, which hastens the destruction of the crystals when oxidizing. This forms insoluble basic iron sulphate, which is deposited as films and masses of copiapite, while the tungsten tri-oxide, although occasionally separating out as tungstite, largely reacts with the alkalies in percolating waters and is carried off in the drainage. Ultimately the leached tungsten may be fixed as a precipitate of insoluble calcium tungstate too finely divided to be recovered by concentration. Wolframite that has been enclosed in unfractured quartz, and thus protected from alkaline solutions, weathers out as a resistant mass in the outcrop. Aside from this it need not be regarded as a difficultly soluble constituent of ore. It is found in the residual accumulations close to the outcrops of tungsten-bearing quartz-dikes, and in the upper drainage leading from the deposits, but as wolframite is comminuted by attrition while the gravel is washed into the larger stream-beds it there undergoes decomposition and fails to remain in placers. Only deposits of scheelite, an insoluble lime tungstate, yield anything resembling placers workable for tungsten.

We would like Mr. Emmons to explain to our readers, and to us, what meaning he gives to the terms 'lode ore' and 'ore lodes.' Is he using 'lode' instead of 'vein,' to signify deposits filling fissures? We venture to make a more serious criticism, namely, the lack of reference to the writings of mining engineers as published in the technical press. For instance, it is unscholarly to ignore the articles recently contributed by Mr. Frank H. Probert on the 'Surficial Indications of Copper.' We might refer to others, but it is unnecessary. Mr. Emmons quotes writers in *Economic Geology*, the *Journal of Geology*, and the U. S. Geological Survey—in short, he contents himself with reference to the work of official geologists either on the Survey or professors in the universities. We think he makes a mistake. While stratigraphy, paleontology, and the hypothetical phases of economic geology may be elucidated by the professional geologists, it is fairly certain that the work of exploration always has been and always will be largely in the hands of the kind of mining engineer who is willing and eager to make the most use of the aid that the science of geology offers to the art of mining. The habit of the gentlemen on the U. S. Geological Survey, even after they resign from the service of the Government, of complimenting each other by frequent mention is admirable so far as it goes, but it is ungenerous to ignore the work of the real pioneers of exploration. Ore is found by the miner and the mining engineer, not by the academic geologist, and it will conduce to a better understanding of the subject if our learned friends will enlarge their mental horizon.

Production of Gold

Sufficient statistical information is now available to warrant an estimate of the amount of gold produced in 1916. The output from many mining regions is not yet known, but, fortunately, 83% of the world's production of gold is made by the English-speaking countries, which issue estimates soon after the close of the year.

	1915	1916
Transvaal	$187,343,185	$191,501,929
Rhodesia	18,542,064	18,912,225
West Africa	8,276,394	7,834,234
Total, Africa	$214,161,643	$218,248,388
Western Australia	25,013,015	21,901,105
Victoria	6,801,835	5,252,143
Queensland	5,161,526	4,722,226
New South Wales	2,738,733	1,852,156
Tasmania	383,366	545,688
South Australia	177,472	124,020
New Zealand	8,739,792	8,186,850
Total, Australasia	$ 49,015,739	$ 42,584,188
Canada	18,977,901	19,162,025
India	11,477,316	11,152,904
Other British territories	3,000,000	3,000,000
Total British Empire	$296,632,599	$294,147,505
United States	101,035,700	92,316,400
Russia	28,500,000	31,000,000
Mexico	15,000,000	12,500,000
Japan and Korea	9,125,400	11,000,000
Other countries	27,000,000	26,000,000
Grand total	$477,293,699	$466,963,905

The pound sterling is taken at $4.85. The African total does not include Madagascar, Abyssinia, Egypt, French

Guinea, and other minor contributors. Of the Australasian figures, South Australia includes the Northern Territory. The recent decrease in gold output from Tasmania is due mainly to the cessation of work at the Beaconsfield mine. In 1905 Tasmania produced gold to the value of $1,470,000. All the Australian States show a decrease, but it is satisfactory to note that the diminution of output in the principal gold-mining region, Western Australia, is smaller than was at one time anticipated, but it is persistent. In 1903 Western Australia yielded $42,679,437, and in that year Australasia contributed $89,206,739 in gold. Last year the Transvaal made the highest production on record, comparing with $61,259,286 in 1903, the year cited in the Australian comparison. Rhodesia and West Africa are holding their own. In 1903 they produced only $4,174,513 and $1,462,671 respectively. The Indian output of gold, all of which comes from four companies operating in the Kolar goldfield, is maintained fairly well, but it is known that the mines are beginning to show impoverishment in depth. In 1899 the Indian output was $8,385,467, and since 1903 it has been maintained at a little over $11,000,000 with a steadiness due to the regulation of production by the conservative managers of this group of mines. The Canadian output has increased during recent years, thanks to Ontario, more particularly the Porcupine district, where the Hollinger, Dome, and McIntyre mines are conspicuously productive. In 1916 Ontario produced $10,117,549, or 52.8% of the Canadian total. The Yukon has lost much of its glory, the yield from this northern territory having declined to $4,391,669 last year, as compared with $22,500,000 in 1901. British Columbia yielded about $4,520,868 last year, chiefly as a by-product from the large-scale copper-mining operations in the Rossland and Boundary districts. Throughout Canada, and particularly in British Columbia, the shortage of labor due to enlistment for the War has curtailed mining operations. The output of the United States declined to the extent of $8,719,300 in 1916 as compared with 1915, but the estimate published at the beginning of the year may undergo a revision that will reduce the supposed loss. In 1915 the first estimate was $98,891,100 or $2,144,600 less than the revised total. Incidentally, this suggests the margin of accuracy in such statistical records. California is still the leading producer. Four States and the Territory of Alaska are responsible for 80% of the United States output. Of the gold produced in the United States only 24% comes from placers, and of this about one-half is won by dredging. Of the $12,500,000 produced by dredging, about $8,000,000 is contributed by California. The smelting of copper ores yields about 8% of all the gold produced in the United States and there is an evident trend toward an increased yield of gold as a by-product from large-scale copper mining. Japan's gold-mining industry has been much stimulated by the War; a gain of 20% in production is reported for 1916 as against 1915. New mines have been opened in the province of Idzu. The latest official figures from Russia were $28,586,390 for the year 1915. The output of that country also has been stimulated by the War, and the State banks are reported to be paying a premium on gold in order to prevent export. This will help the statisticians, because stealing of gold in the mines causes much of it to pass into foreign hands, and so evade accounting. The chief gold-mining district is the Bodaibo, in the Lena watershed, which contributed 30% of the Russian output in 1915, when one company, the Lena Goldfields or Lenskoie, produced $8,646,997 from 902,459 yards of gravel. Europe yields less than 2% of the world's gold output, for nearly all the Russian supply is of Siberian origin, the Ural being responsible for $1,000,000 only. The gold mines of France, led by the La Belliere, had become less productive before the War, and those of Hungary are now chiefly of historic interest. The gold credited to Germany is largely derived from the smelting of foreign ores. The British dominions yield 63% of the world's gold. The British Empire, the United States, and Russia produce 90% of the world's output of gold.

The Decision

Never has a nation approached the supreme arbitrament of war more deliberately and more regretfully than the United States at this time. The American people believes in peace at any price, even at the price of war, and when it draws the sword it will be with the earnest expectation not only of shortening the existing horror in Europe but of preventing a recurrence of a like calamity in the future. The President has not identified himself with either extreme party, the militarists or the pacifists; on the contrary, he has represented the nation that recently re-elected him to leadership. The hesitation to become actively embroiled and forcibly to resent injury will give to the American decision a moral value that should prove effective. On the surface the belated participation in the conflict will seem prompted by an intention to assert the freedom of the seas, to protect commerce, and to protest against the abuse of diplomatic hospitality that accompanied a scheme to let loose the Mexican and the Japanese upon us, but history, making a closer analysis, will ascertain that the violation of Belgium, the deportation of her people, the butcheries in Armenia, and the assassinations on the Atlantic brought the American people to a realization of the fact that the world would be unfit for orderly living should such savagery emerge triumphant. It is no mere coincidence that in this moment of final crisis the republic founded by Washington and sanctified by Lincoln should respond to the call not only of the free peoples of France and England but of a new democracy that arises over the wreckage of the absolutism that has so long weighed upon the Russian people. This triumph of liberalism proves, if proof were needed, that the Allies are fighting for democratic principles, for the right to live and let live, for a place in the sun for all men. The great imponderables have weighted the scales of justice and right shall prevail.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Mine Samples as Baggage

The Editor:

Sir—Not long since I made a mine examination in Nevada, and during the investigation of the property, I took a large number of samples, all of which, after cutting down, were placed in the usual small sample-sacks, and these I put in two large canvas sacks of the mail-pouch sort, with a view to distributing the weight, as I had my outfit (working-clothes, etc.) also divided between the two sacks. When I reached the railroad, at Tonopah, and attempted to have the sacks checked as personal baggage, their weight caused the baggage-agent to inquire if the sacks contained samples. To preserve my reputation I reluctantly admitted that they did, whereupon he refused to check the sacks, informing me that they would have to go by freight, or by express. I was compelled therefore to open both sacks and to transfer all the samples to one sack, and my clothing to the other. He then checked the sack containing the clothes, and I was obliged to send the samples by express to San Francisco, or wait a week or more for their arrival by freight.

I was told, though not by the agent, that it was part of a general scheme to discourage high-grading. There was surely no need of it in this particular instance, and, if the excuse mentioned was the real reason for this custom of the railroad company, then, to make it effective, every lot of samples sent through the express office would be subject to search, which no engineer would contemplate with indifference. I seriously doubt whether this explanation is the true one, but rather, that it is wholly due to the desire to make more business for the express and railroad companies.

It seems to me that the railroad company, at least, makes a great mistake in adopting and continuing a business policy so narrow. I never managed a railroad, but I have run a mine or two, and if I were operating a railroad I think I would consider it good business to change without delay the policy above referred to. In Nevada the principal business is mining. It furnishes probably 90% of all the local railroad business in that State. Since this is so, it looks like a lack of business acumen to do anything that would have a tendency to place a handicap on the development of mining. An engineer goes out to examine a mine and returns with a lot of samples weighing anywhere from, say, 25 to 100 pounds or even more. These he must send home by express or pack them into the railroad car with him. It may be that as the direct result of this examination, the railroad company will eventually derive business worth many thousands of dollars annually for a long time.

Possibly this phase of the subject has never been brought to the attention of railroad managers, for it seems, if it had, this parsimonious policy would be abandoned for a more liberal one that would encourage mining, not penalize it, and one that would ultimately be of direct and great advantage to the railroad company.

HORACE STANTON.

San Francisco, March 5.

Effects of Faults on Richness of Ore

The Editor:

Sir—That faults, both great and small, appear in many instances to have had a direct influence on the value of ore in that part of the vein adjacent to the fracture has long since been recognized. A vein in which the normal ore is poor, in many instances is found to have been enriched to a surprising extent just above the plane of the fault, while the ore below the break is usually of nominal value.

I have observed frequently that where the plane of the dislocating fault—or it may be a dike—is at a high angle, the enrichment may be found on both sides of the fracture. To no class of workers is the influence of these 'breaks' in veins more suggestive than to the experienced pocket-miner. Aside from the actual work of drilling, blasting, and timbering in his mine, careful and discriminating observation of geological conditions is the main business of the pocket-miner. He is a close student of these changing variations in the structure and character of his vein, and of the condition of the formation in which it occurs, or that may be intruded into it, as well as of the faults and seams that cross it, or that unite with it. He knows by experience that he usually finds his gold at the intersection of these various fissures with his vein, and he observes with painstaking care every change of condition, for on his understanding of these characteristics depends his success.

Generally, though not always, pockets of gold occur at the intersection of these planes, of which the vein is one. The two others are called 'crossings' and 'gold-seams.' The crossings are small fissures that strike across the vein at a high angle, regardless of the strike and dip of the vein itself. The 'gold-seams' comprise a second series of fissures, sometimes inconspicuous—often mere threads, which have a strike approximating that of the vein, but dip across it at any angle between horizontal and vertical. There are many exceptions to this—mines

in which a concentration of gold, a pocket, is found in the vein adjacent to a crossing seam, fault, or dike, with no third intersecting plane visible.

In a mine, near Groveland, California, I saw a vein, one foot thick, that was nearly flat and intersected a formation of vertical clay-slate. A fault, parallel with the slate in strike and dip, had dislocated the vein about 20 inches. The material filling the fault between the upper and lower segments of the displaced vein was filled with crushed slate and fragments of quartz, and was rich in coarse gold, producing several thousand dollars in about 70 ft. of drift. The vein itself, for 10 or 12 ft. on each side of the fault, contained ore rich enough to pay to work in an arrastra, but beyond that the quartz was without value. Another interesting occurrence was observed in the Bandarita mine, 10 miles east of Coulterville, in Mariposa county. There a vein, four feet wide, was prospected by a drift run from a cross-cut adit. The vein was low-grade—much too low to pay—but a felsite dike diagonally crossed the strike of the vein, and here on the hanging-wall side of the dike and along its intersection with the vein, was found an accumulation of gold, which was followed upward by the miners. This 'bunch' was worth $20,000, so said the miners. It extended upward about 40 ft. along the line of intersection of the vein and dike. Why it did not go farther it is impossible to say. There was no similar accumulation of gold on the under side of the dike, in fact, scarcely any gold at all, though the quartz persisted.

Hundreds of pockets of gold, large and small, have been mined in California, and in nearly every instance the gold has been found at the intersection of two or more, but most commonly of three planes, as above described. One of the most profitable and consequently most noted pocket-mines in the State is the Bonanza in the town of Sonora, in Tuolumne county, four miles east of the Mother Lode. It is the most famous pocket-mine in California and has produced over $2,000,000. It was discovered in 1850 and was worked for many years in a small way. Until the early 'eighties it had no mill, all the gold was recovered by use of hand-mortar and pan. In later years it was equipped with a small stamp-mill. The shaft is down over 1300 ft. In value the pockets have been worth from a few dollars to $360,000. This latter was found 200 ft. below the outcrop, and the central mass was worth $40,000, the remainder of the pocket being scattered for several feet through the accompanying quartz and dike-rock. The Bonanza 'vein,' if it be proper to call it such, is a dike of light greenish rock of felsitic texture. It is remarkably uniform in color and texture throughout, except at and near the surface, where it is much decomposed, soft, and stained brown by iron oxide. In the unoxidized portions the rock is usually filled with greenish chloritic scales. In width the dike varies from 8 to 16 ft.; it strikes north 30° east, and dips at 20 to 25° north-west. With the possible exception of a large diorite dike found at the 1300-ft. level, the Bonanza dike is the latest intrusion in the vicinity. It cuts several other dikes intercalated in the slate and schist of the Calaveras formation. The slate, schist, and other rocks of this formation, strike N. 30° W. and dip 65 to 70° N-E. The most important of these rocks is a zone of clay-slate 4 to 12 ft. wide, containing 5 to 10% of pyrite in brilliant cubes. This is the metallic-slate of the miners—the pocket-making slate. West of this is massive argillite, showing slight slaty structure. On the east side of the pyritiferous slate is a zone of dense quartzose rock, probably silicified argillite, beyond which on the east is a bed of limestone. Still farther east other zones of slate, schist, quartzite, and limestone occur; these are cut by the Bonanza dike in the same manner as in the Bonanza mine, and in some of the slaty bands pockets of gold are found under much the same conditions. At this mine it is only in association with the band of pyritiferous slate that gold occurs —not in the slate, but within the dike. In the band of 'metallic slate' are four stringers or veinlets, not over three inches wide at any place, and usually but a small fraction of an inch. One of these fissures separates the massive argillite side from the 'metallic' slate; the other three are within the zone of this slate, and vary in their distribution, being from one to four feet apart. These veinlets are nearly parallel with the enclosing slate. The most westerly one is accompanied by thin strips of mineral that look like decomposed intrusive igneous material mixed with iron oxide and black oxide of manganese—the 'fuse' of the pocket-miner. Occasionally, in this same fissure, small strips of quartz, like a thin lens or ribbon, has formed. The remaining fissures contain only clay-like mineral, due to the crushing and decomposition of the slaty rock. These are the veinlets known as 'crossings.' A second series called 'gold-seams' cuts both the strike and dip of the slates and crosses the dike with a south-west dip. Presumably these crossings and gold-seams pass into the foot-wall slate, but as no mining has been done below the dike it is not known whether other pocket zones lie beneath. None are seen to outcrop at the surface in the foot-wall of the dike. Both crossings and gold-seams have had an influence on the dike, as the two systems of fracture were found crossing it, where they appeared as waving veinlets of quartz, which, together with three larger veins of quartz, divided the dike into a series of rhomboidal blocks.

The dike cuts the slate diagonally in dip and strike. A vein of quartz of variable thickness lies next to the hanging wall, being a replacement of dike-material. A similar vein lies on the foot-wall, and a third vein formed about mid-way of the walls, being separated from the hanging and foot-wall veins by two to six feet of dike material. These three veins are from an inch or two up to two feet thick, and, except in the vicinity of pockets, are practically barren of gold. In the lower workings of the mine these three veins united to form one vein, which occupied the middle portion of the dike, and with this change in condition the enrichment of the dike ceased, except here and there a small 'bunch' worth a few dollars. As mentioned previously, the 'crossings'

and 'gold-seams' traverse the dike in the form of veinlets of quartz—the crossings at a high angle, approximating the laminations of the slate, and the gold-seams, nearly flat, as they were in the slate. It was at the intersection of these crossings and gold-seams with the three veins of quartz in the dike that the pockets were found, and always opposite the zone of black 'metallic' slate—never elsewhere, in this mine. A remarkable thing is that years of experience in the operation of the Bonanza mine proved that, as a rule, the pockets of gold formed at alternate intersections; but the value of any pocket could never be anticipated. The gold was generally brilliant in appearance and often was accompanied by equally brilliant crystals of the tellurides of gold and silver, particularly petzite. The Bonanza dike is in the plane of a thrust-fault, the hanging-wall side having moved upward and to the west a distance of 16 ft., which is approximately the thickness of the dike. On the whole, the occurrence of the gold pockets in this remarkable mine might be described as an ore-shoot about 16 ft. long, from 12 to 16 ft. thick, and about 1200 ft. deep, on the dip of the vein, as nearly all of the gold recovered was found within those narrow limits.

W. H. Storms.

Berkeley, January 24.

Socketing a Wire-Rope

The Editor:

Sir—Notwithstanding the fact that the device for socketing a wire-rope that appeared in your issue of March 10 has the stamp of so well-known a firm of wire-rope makers as Roebling Sons & Co., I am disposed to doubt its security for three reasons. First, the strength of the joint is dependent entirely on the assumption that the surfaces of the individual wires of the rope become alloyed with the zinc to form a solid piece of metal. This may happen in the hands of a skilled operator. It is likely not to happen in the hands of the average mine-blacksmith or mill-wright, to whom such work is generally assigned. Even if the job is well done, I am inclined to think the breaking strength at the socket will be considerably less than that of the rope—an undesirable state of affairs. Second, I dislike the use of hydrochloric acid. Should a little of the acid be soaked up by the central hemp rope it would be liable to set up incipient corrosion from the inside outward, where it would not be detected easily, and might lead to a serious accident. It is a well-known fact that zinc chloride is barred as a soldering flux for electric wiring solely because of the danger that may accrue if the flux is not properly cleaned from the wires after the soldering has been done. Why not be as cautious in socketing a rope? Third, the heat of molten zinc may anneal, and, thereby, weaken the wire immediately below the socket.

An infinitely easier and, I believe, more secure way of socketing a wire-rope is to push the end of the rope through the socket, allowing a piece the length of the socket to project, wrap the rope below the socket, to prevent unraveling, remove the central hemp rope, and bend the individual wires back into the socket, decreasing their length as the socket becomes filled, and, if necessary, cutting off those wires for which there is no room. Finally, hammer securely in place.

Incidentally, why is the purely nautical synonym for wrap, 'serve,' used in the description of Roebling Sons & Co. when the former is so much more readily understood?

F. H. Mason.

San Diego, Cal., March 13.

Some Pertinent Questions

The Editor:

Sir—In your issue of January 13 there appeared some 20 or more questions, which to date have been answered in one way or another. Our friend, Lucien Eaton, of Ishpeming, in your issue of February 10, described the various conditions that affect results in each case. He has not described all of the conditions by any means. As an example: "How far should a trammer push a loaded car on a fair track underground in one minute?" It makes little difference whether he is underground or out on the dump. It does make a difference, however, as to length of his legs, age of the trammer, his temperament, whether forenoon or afternoon, how long he has been on the job, whether 'bohunk' or an American lad getting a few dollars for his next year in college. Any and all of the questions could be answered in wide limits. To date there has appeared 70 inches of good reading devoted to this subject, and I am sure I voice the sentiment of the mining profession when I say that we want more such articles as 'The Nickle Plate Mine and Mill,' 'Trips Through British Columbia,' and 'Dredging for Gold on Seward Peninsula,' and numerous others of this kind that have appeared from time to time.

A Careful Reader.

Takilma, Oregon, February 17.

In local chlorination plants in California the cost of treating auriferous pyrite ranges from $5 to $9 per ton depending upon the cost and kind of fuel employed (whether wood or crude petroleum), cost of labor, and size and capacity of the furnace. Barrel chlorination is more satisfactory than the Plattner process, and for some ores is superior to cyanidation. The largest chlorination plants ever built and operated successfully in the United States were those at Deadwood, in the Black Hills of South Dakota. These plants have not been in use, however, for many pears.

A shipment of $25,000,000 gold was received at the Philadelphia mint on Saturday evening, March 10, from New York for account of J. P. Morgan & Co., it being necessary to keep the establishment open many hours after closing time. Added to what is already stored here, there is now approximately $185,000,000 gold in the vaults. This quantity of gold weighs about 111 tons.

Exploration of Metalliferous Deposits

By W. H. Emmons

Introduction. *The exploration of deposits of the metals will never become an exact science. There will always be an element of uncertainty in prospecting and developing mines. In countries where the surface has been closely scrutinized, most of the deposits whose outcrops contain valuable metals have probably been discovered. Many metalliferous deposits, however, are normally so very much altered at the surface that the true significance of their outcrops is most likely to be obscured.

If a deposit is not exposed its presence may become known by some one of its characteristics that is different in kind or in degree from a similar feature of the associated rock. Thus, a deposit that is not exposed may be discovered because of its magnetic property. So few minerals are strongly magnetic that the value of magnetic surveys is limited, but the dip-needle has nevertheless proved of great aid in detecting magnetic belts, and these in some regions are associated with workable iron ores. The Cuyuna iron range of Minnesota, which does not exhibit any outcrop of iron ore, was discovered by drilling 'areas of attraction' that are due to belts of magnetic rocks associated with the iron ores. In some regions the use of the dip-needle is justified, even if it does no more than reveal the strike of the rocks, since a knowledge of the latter enables the driller to place and point his holes to advantage.

The measures of gravity by the use of the pendulum are so accurate, or the limit of error is so small, than one might detect the presence of a concealed tabular deposit approximately at the surface, 34 ft. thick, having a density double that of the surrounding rocks. However, not many deposits have a density twice that of ordinary rocks and a thickness as great as 34 ft.; if they lie a short distance below the surface the density or the thickness must be even greater. Consequently, there is not much hope of sufficiently developing the gravity method of detecting deposits of heavy ores to make it of practical value. If the limit of error could be reduced to about one-tenth the present factor, and if the rather tedious and painstaking methods of determining gravity that are now in use could be simplified, the method would promise some degree of usefulness in the exploration of certain types of heavy ores. This, however, seems unlikely, since great refinement of method is necessary to determine the degree of error that now exists. In the future, as in the past, the explorer will probably have to rely upon what he sees rather than upon some peculiar characteristic of concealed deposits.

*A paper to be read before the St. Louis meeting of the American Institute of Mining Engineers in September 1917.

Certain relations of the distribution of lode ores to geologic structures have long been recognized. They are deposited principally in regions of complex faulting and fracturing and in areas of volcanic activity. The earlier prospector found that it was profitable to scrutinize the mountainous regions, for these in general are most complexly faulted and fractured, and more likely to have been the centres of great igneous activities. In some regions, it is true, flat-lying rocks far removed from igneous centres yield deposits of the valuable metals; these, however, are rarely of the lode type.

Certain features of a region other than its outcrops may lead one to suspect the presence of ore lodes. Thus, the presence of placers will lead to a search for the sources of the metals they contain. In some regions, waters containing iron sulphate suggest the presence of deposits containing iron sulphides. At some places, many feet above the present streams, gravels are cemented by iron oxides that were evidently derived from the weathering of deposits containing iron sulphides. At Cananea, at Bingham, at Lead below the Homestake lode, and in many other regions, iron-cemented gravels are conspicuously developed. These gravels were consolidated, long before the mines above them were opened, doubtless by iron oxide that was deposited by hydrolysis of iron sulphate formed by oxidation of pyrite during the weathering of the pyritic deposits.

Lode ores, it is believed, are deposited principally by ascending hot waters. This inference is justified since they are almost universally associated with intrusive igneous rocks. The solutions that course through fractures and shattered zones soak into the country-rock. In some districts these solutions have wandered far from the master-fractures, profoundly altering great areas of country-rock. Where the prevailing hydro-thermal alterations are sericitic, as at Butte, and in many other regions, the rock is bleached. Where the alterations are propylitic, as in many of the precious-metal deposits of Nevada, igneous rocks, by development of chlorites from dark minerals, become pale green. Prospectors, even those without academic training, know the significance of hydro-thermal metamorphism. Some designate the result of such alteration as the 'kindly look' of the rock and contrast it with the 'hungry look' of the fresh unaltered rock which they have often found to be barren of ore.

Primary ore deposits fall into a few well-defined groups, each with characteristic features. These in different districts have definite relations to the geologic structure, depending on their genesis. The mapping of the structures and the investigation of the relations of

the deposits to structures are essential features of rational exploration.

Of the discoveries made in the United States within the past 10 years, perhaps as many have resulted from a knowledge of the geologic conditions of the districts containing the deposits as from the exploration of outcrops that were supposed to be the altered caps of valuable deposits. The exploration made with an adequate knowledge of the structure of an area and also with an understanding of its characteristic superficial alteration is the most likely to succeed.

Some outcrops themselves contain the valuable metals; others have had the valuable metals leached from them, but may carry the alteration-products of associated minerals, and these frequently furnish the clue leading to the discovery of orebodies. Pyritic copper-sulphide deposits and pyritic zinc-sulphide deposits are generally leached of copper and zinc near the surface. In the earlier days of mining many of the deposits were discovered incidental to mining associated metals less readily dissolved at the surface. In general, these deposits were stained with iron oxide. The copper deposits and zinc deposits of Butte were discovered by exploration of silver ores in the upper oxidized parts of the veins. The United Verde mine at Jerome, the Highland Boy mine at Bingham, and the Mount Morgan mine, in Queensland, were worked first as gold mines. All subsequently developed great bodies of copper ore carrying noteworthy amounts of gold.

Stimulated by examples of iron-stained rocks passing downward into workable copper ores, explorers investigated ferruginous outcrops systematically and many deposits were discovered below the valueless caps. Many of the disseminated copper deposits are barren of copper at the surface. The exploration of these deposits soon showed, also, that some are not everywhere capped by gossans heavily stained with iron oxide. The cap-rock in general is composed largely of sericite, kaolin, and chalcedonic silica. Some contain also sulphates. Such associations, though not so easily recognized as limonitic areas, are nevertheless significant and the recognition of the origin of such an outcrop is certain to play an increasingly important part in the explorations of the future. Because such an association of alteration-products is less readily recognized, outcrops of this character are the most likely to have been overlooked in an area that has not been fully explored.

The problems connected with the superficial alteration of ore deposits, although complex, are susceptible of analysis and experimental study. The changes are accomplished by water, air, and the compounds resulting from the action of water and air upon the ore itself. One may take the ore, expose it to water and air, and ascertain what products are formed. One may expose the ore further to the action of water and those products in the absence of air and ascertain the changes accomplished. By analysis one may ascertain the composition of the waters of mines. There are now available more than 50 analyses of waters from mines of sulphide ores. These are similar in composition and closely resemble solutions formed by placing sulphide ore in contact with pure water. It may be assumed with confidence that the solutions that accomplished superficial alteration of sulphide ores are systems of sulphates, carbonates, and chlorides of heavy metals, of alkalies, and of alkaline earths. Near the surface the solutions are acid and generally contain ferric sulphate. In depth, ferric sulphate is reduced to ferrous sulphate, acidity is decreased by reaction with minerals of the ore and wall-rock, and at greater depths the solutions become neutral and ultimately alkaline. Subjecting for long periods various minerals and various combinations of minerals to solutions such as are known to accomplish superficial alteration, one may ascertain what changes take place and compare the re-activities of ores of the various metals and their re-activities in various mineral associations.[1]

Some of the metals are easily dissolved near the surface where waters are acid and oxidizing. Of these some are precipitated in depth where acidity decreases and where solutions are reduced because oxygen of the air is excluded. Deposits of such metals are likely to be leached at the surface. If the metals are readily precipitated in depth the deposits become enriched below the surface. Other metals are difficultly soluble and because associated materials are dissolved and removed deposits of the former are likely to be enriched at the surface. Associated gangue-minerals are important also because some metals dissolve readily in certain associations but not in others. One may separate the metals into groups —one of metals that dissolve readily, another of metals that dissolve slowly, and still another of metals that dissolve very slowly.

1. Dissolve Readily	2. Dissolve Slowly	3. Dissolve Very Slowly
Copper	Mercury	Gold (in part)
Zinc	Lead	Bismuth
Silver	Antimony	Tin
Gold (in part)	Arsenic	Chromium
Uranium		Molybdenum
Vanadium		Tungsten
Iron		
Manganese		
Nickel		
Cobalt		

Copper, because of its chemical relations, is easily leached from the surface and precipitated in depth. As already observed, the outcrops of a copper sulphide deposit may be so thoroughly leached that practically all the copper is removed and carried downward.

In base-leveled countries or in countries where the surface has remained nearly stationary for a long time, the outcrops are generally depleted of copper. Even in mountainous countries, where erosion is comparatively rapid, not many large deposits of copper are workable at the surface. Ferric sulphate hydrolyzes, depositing limonite, so the deposits of many iron-copper sulphide

[1] W. H. Emmons: 'The Enrichment of Ore Deposits,' U. S. G. S. (1917), Bulletin 625.

ores are marked by a gossan or 'iron hat.' As already noted, many copper deposits have been discovered by following downward a nearly barren gossan or by the downward exploitation of deposits of precious metals that are concentrated near the surface above deposits of copper ores in which the precious metals are present in small amounts.

In copper deposits that do not carry sulphides the downward transportation of copper is generally slow. The native copper deposits of Keweenaw Point, Michigan, are workable at the surface, although the country has undergone erosion for a period so long that it has become nearly a peneplain.

Where the sulphides are present in subordinate quantities, copper carbonates and silicates may occur abundantly at and near the surface, as at Ajo, Arizona,[2] where oxidized copper minerals are conspicuous in outcrops.

In limestone, copper will commonly segregate as carbonate at and near the surface, and many oxidized copper deposits in limestone have been worked by open pits. Limestones that have been altered by contact metamorphism are relatively impermeable, because their tough, heavy silicates, such as garnet, amphibole, and mica, are not readily fractured. Most deposits of this nature contain considerable calcite, and any copper-iron sulphides they carry will usually oxidize to carbonates, silicates, and oxides. The copper in such an ore is particularly stable and is likely to endure long weathering. Such deposits have stimulated deep prospecting in many districts where other types of deeper copper ores are present,[3] and they have thus served as useful indicators of hidden wealth.

The copper lodes in igneous rocks at Butte are leached of copper, some of them to a depth of 400 ft. The disseminated ores in porphyry show great variation as to depth of leaching, but are commonly leached to depths of 100 to 300 ft. below the surface, and exceptionally at greater depths. Some of them show practically no copper at the surface. At Cananea and Morenci, barren gossans that were explored to considerable depths have led to good deposits of chalcocite ore. Copper was only sparingly present at most places in the outcrops of the great disseminated deposits at Miami and Ray, Arizona. At Bingham is was locally somewhat conspicuous as carbonates and silicates.

In making explorations for copper the question frequently is raised whether drilling is justified in an area that shows but little iron oxide at the surface. Nearly all copper deposits mined in North America do show ferruginous outcrops, but some gossans that cap valuable disseminated ores in porphyry are not heavily stained with iron. At Cananea, Sonora, valuable chalcocite deposits occur below outcrops that show heavy iron stain only here and there. As stated above, however, the outcrops show much silicification and kaolinization, and generally some limonite is present.

As a rule, the disseminated deposits of chalcocite ore will show outcrops more highly stained with iron in the earlier stages of their chalcocitization. As the country is eroded and the chalcocite zone descends, more and more pyrite and chalcopyrite are replaced by copper sulphides. A point may be reached where the chalcocite ore contains very little of the original iron sulphide. Obviously the oxidation of such an ore would yield but little iron sulphate. It would yield even less limonite, if the solutions were actively descending. If the process goes still further, the proportion of iron may become insufficient to dissolve all the copper in the chalcocite zone. The gossan then will generally carry oxidized copper minerals such as the carbonates, basic sulphates, and chrysocolla.

Zinc, like copper, is readily dissolved from its sulphide deposits and in the presence of much pyrite or other iron sulphide near the surface, the zinc is likely to be almost completely removed from its deposits. It forms the soluble zinc sulphate. But zinc in depth is not so readily precipitated by sulphides as copper. It will remain dissolved in solutions in which copper may be precipitated. Thus secondary concentrations of zinc-sulphide ores are rare compared with the secondary ores of copper.

In limestone, a solution of zinc sulphate precipitates zinc carbonate ores. These ores have lately become prominent, particularly in several districts of western America, where surficial changes have produced notable concentration of zinc.[4]

A common type of ore in limestone consists of pyrite, argentiferous galena, sphalerite, a little chalcopyrite, and other sulphides in a gangue of quartz. The orebodies, like many deposits in limestone, are commonly large irregular masses. In the oxidation of such a deposit the lead and much of the silver remain essentially in place, the galena being in part oxidized to anglesite and cerussite. The oxidation of pyrite and sphalerite yields acid, and zinc and iron sulphates, which are carried out of the deposits in great quantities. A part of the iron remains behind as oxide, but in some deposits practically all the zinc is removed. When the solution, which is doubtless acid and carries ferric, ferrous, and zinc sulphates, moving along a water-channel, encounters the limestone that surrounds the orebody, it will precipitate iron and zinc.

Under some conditions a zinc-iron carbonate or sideritic smithsonite, monheimite, is formed. This reaction has recently been investigated by Wells.[5] Dilute solu-

[2]I. B. Joralemon: 'The Ajo Copper-Mining District,' Trans. A. I. M. E. (1915), 49, 601.

[3]W. H. Emmons: 'The Outcrops of Ore Deposits,' in 'Types of Ore Deposits,' H. F., Bain, and others, p. 318, San Francisco, 1911.

[4]G. M. Butler: 'Some Recent Developments at Leadville,' *Economic Geology* (1913), 8, 1.

Adolph Knopf: 'Mineral Resources of the Inyo and White Mountains, California,' U. S. G. S. (1914), Bull. 540, 97.

G. F. Loughlin: 'The Oxidized Zinc Ores of Tintic District, Utah,' *Economic Geology* (1914), 9, 1.

[5]R. C. Wells: 'The Fractional Precipitation of Carbonates,' *Washington Academy Scientific Journal* (1911), 1, 21.

tions of two metallic salts in equivalent (molar) quantities were precipitated with only enough sodium carbonate for one metal. With equivalent quantities of zinc and calcium nearly all the zinc and only a trace of calcium are precipitated. With equivalent quantities of iron and calcium, nearly all the iron and only a trace of calcium are precipitated. Sideritic smithsonite, or monheimite, contains iron carbonate in varying proportions. Some smithsonite is nearly pure and some contains as much as 20% of iron carbonate, or even more.

After it is formed the smithsonite, or monheimite, with the progress of the erosion of the country, is exposed to more highly oxygenated waters. The iron carbonate then oxidizes and stains the ore brown so that it may be easily mistaken for iron-stained limestone. Thus deposits of this character, though exposed in underground workings, have been overlooked for years.

SILVER, like copper, is readily dissolved in ground-waters. If the chloride forms in the gossan its solution is delayed. The chloride, however, is to be regarded as a temporary mineral except in arid countries[6] where chlorine is commonly present in considerable quantities in earth waters. In such countries more chloride forms and, moreover, its solution is prevented by chlorides present in the waters. There may, therefore, be great enrichment of silver at and near the surface. In depth, silver is carried in acid solution. Air or ferric iron is necessary for its active solution in sulphate waters.[7] However, the carbonate of silver is soluble and without much doubt some silver is carried downward in carbonated waters. Silver is precipitated from its sulphates[8] and carbonates[9] in a sulphide environment. For this reason great bodies of secondary silver ore may be deposited below a leached or low-grade capping.

GOLD is readily dissolved in acid waters that carry chlorides in the presence of manganese oxides;[10] by reduction of acidity, gold is precipitated. Frequently the manganese and gold are precipitated together; in deposits that contain manganese, gold may be carried downward in solution and accumulate below the outcrop. But gold is readily precipitated from its solutions by many minerals, and its migration is slow. In the presence of carbonates[11] or of other minerals that yield alkalies readily, gold in manganiferous deposits tends to remain near the surface and in manganiferous carbonate gangue it may even accumulate as placers. If the metal were not of great value, its secondary concentration would be of little economic importance because it is dissolved near the surface only in chloride solution and chlorides are much less abundant than sulphates. In deposits which do not contain manganese, gold dissolves very slowly, if at all, and tends to accumulate at the surface, these deposits being enriched by removal of material other than gold.

URANIUM AND VANADIUM are readily dissolved in sulphate waters and both are regarded as mobile metals. Both metals are precipitated from the soluble salts by organic matter.[12] The carnotite deposits of Colorado[13] are believed to be concentrations from cold ground-waters that dissolved the metals from associated rocks. In many deposits, vanadium minerals occur in relations that leave no doubt of their secondary origin.

IRON AND MANGANESE are grouped with the metals that are readily dissolved. In sulphide deposits containing iron and manganese these metals are generally present in ground-waters. The iron and manganese solutions, however, are not stable and the oxides of iron and manganese are readily precipitated by hydrolysis. Consequently deposits that contain appreciable amounts of iron and manganese will generally carry these metals at the surface. Secondary deposits of iron sulphide or manganese sulphide are almost unknown. In depth, iron and manganese are deposited along fractures as oxides and more rarely as carbonates, but these deposits in lode ores are of relatively small importance. Deposits of iron and manganese are commonly enriched by removal of other materials. In general, iron and manganese deposits carry rich ores at the surface.

NICKEL is similar to iron in its chemical activities, but unlike iron it does not oxidize from bivalent to trivalent salts and its sulphate does not hydrolize and deposit oxide. It is dissolved almost as readily as copper in its sulphide combinations and it is precipitated in depth as sulphide. It is not so easily precipitated as copper sulphide, however, and will not be thrown down in an acid environment. It, therefore, resembles zinc in its migrational activities more closely than it resembles copper. No large deposits of secondary nickel have been recognized. The best known deposits of nickel sulphide ores have been glaciated and possibly secondary sulphide zones have been removed. At the Lancaster Gap nickel mine,[14] Pennsylvania, secondary millerite is said to have been present in bodies of economic value. The gossan of nickeliferous pyrrhotite is essentially limonite. In the weathering of nickeliferous basic rocks the nickel accumulates as silicates not far below the surface.

COBALT salts are soluble and cobalt is dissolved readily from outcrops. No deposits of secondary sulphides are known. Its chemical behavior is closely similar to that of

[6] R. A. F. Penrose, Jr.: 'The Superficial Alteration of Ore Deposits,' *Journal of Geology* (1892), 2, 288-317.

[7] H. C. Cooke: 'The Secondary Enrichment of Silver Ores,' *Journal of Geology* (1912), 21, 9.

[8] Chase Palmer and E. S. Bastin: 'Metallic Minerals as Precipitants of Silver and Gold,' *Economic Geology* (1913), 8, 140. F. F. Grout: *Ibid.* (1913), 8, 407-433.

[9] L. G. Ravicz: 'Enrichment of Silver Ores,' *Economic Geology* (1915), 10, 368-392.

[10] W. H. Emmons: 'The Agency of Manganese in the Superficial Alteration and Secondary Enrichment of Gold Deposits in the United States,' Trans. A. I. M. E. (1913), 42, 3-73.

[11] A. D. Brokaw: 'The Secondary Precipitation of Gold in Orebodies,' *Journal of Geology* (1913), 21, 251-268.

[12] F. L. Hess: 'An Hypothesis for the Origin of the Carnotites of Colorado and Utah,' *Economic Geology* (1914), 9, 675-688.

[13] W. F. Hillebrand and F. L. Ransome: 'On Carnotite and Associated Vanadiferous Minerals in Western Colorado.' U. S. G. S. (1905), Bull. 262, 14.

[14] J. F. Kemp: 'The Lancaster Gap Nickel Mine,' Trans. (1894), 24, 620.

nickel and zinc and it should be grouped with the metals that might be concentrated under favorable conditions. Like nickel, cobalt forms silicates and concentrates in the superficial zones of silicate deposits which are undergoing alteration. Cobalt, like nickel, forms a moderately insoluble arsenate in some outcrops. Cobalt is found in considerable quantities in the oxidized material which caps the altered peridotite at New Caledonia.

MERCURY is dissolved and re-precipitated in underground waters. The reactions proceed readily with chloride waters, but not in sulphate solutions. Mercuric chloride is soluble in water and does not give insoluble basic salts with water. Mercuric sulphate, on the other hand, is easily hydrolyzed and gives basic sulphate which is reduced to native metal. Experiments made over long periods by T. M. Broderick[15] show that cinnabar is practically insoluble in sulphate waters, although it is readily dissolved in hydrochloric acid, and more readily still in presence of manganese oxide. The secondary enrichment of mercury deposits is somewhat similar to that of gold. Neither metal is appreciably dissolved except in presence of chloride. Re-concentration of mercury is most marked in arid countries where chlorides are present. Chlorine, however, is quite subordinate in underground waters compared with sulphates. The waters, therefore, could not move large masses of the metal and concentrate them as copper and silver are concentrated. Gold is so valuable that even small concentrations are important economically. Mercury is less valuable: a concentration of 2 oz. of gold per ton would be highly significant, but 2 oz. of mercury per ton would be unimportant. There is indisputable evidence that secondary mercury minerals result from processes of sulphide enrichment, but these are small in amount because chlorides in general are not abundant in waters of deposits of mercury ores. Mercury must be placed with metals that are non-migratory.

LEAD is one of the least soluble of the common metals, although the chloride is fairly soluble and the sulphide is dissolved in sulphuric acid in the presence of an oxidizing agent. The oxidation is attended by the formation of the relatively insoluble lead sulphate, anglesite. This coats the sulphide and tends to delay solution. Deposits with ores carrying galena will generally contain oxidized lead minerals near the surface. It is not uncommon to find galena partly altered to anglesite in the outcrops of deposits containing lead sulphide. Lead minerals, because of their low solubilities, are useful indicators of mineral deposits, and at many places have led to the discovery of silver, gold, and zinc deposits. Like deposits of other difficultly soluble metals, lead deposits are likely to be enriched by removal of valueless materials rather than by concentration in depth by the processes of solution and precipitation.

ANTIMONY dissolves slowly in the oxidized zone. Its sulphide deposits form the oxides which are about as stable as the secondary lead minerals, cerussite and anglesite. In depth, however, antimony minerals dissolve readily in alkaline solution. The antimony salts unite with silver-bearing solutions and precipitate antimony sulpho-salts of silver. Antimony is not to be classed as a readily migratory metal though it plays an important part in the precipitation of the secondary silver minerals.

ARSENIC dissolves rather readily in acid solutions but if it is present as a salt of H_3AsO_3 much water will hydrolyze it, and if present as salts of a base-forming element these also are hydrolyzed. In an acid solution its salts are oxidized but do not migrate extensively. In alkaline solutions, however, they are easily dissolved and in depth the activities of arsenic in connection with the secondary enrichment of silver are important.

BISMUTH is more or less closely allied to antimony and arsenic. Like them it forms oxides near the surface in its deposits. There is no evidence of its extensive migration. From its chemical relations it is not likely that important secondary zones formed by the migration of bismuth will be found. Its sulphate hydrolyzes readily in water and in weak acid-forming oxides and its other salts also hydrolyze so readily that they would not be transported.

TIN is one of the more inert metals. The stannous salts, both sulphate and chloride, are easily soluble, but the stannic salts are readily hydrolyzed. Thus, in an oxidizing environment such as obtains in sulphide ores near the surface of the earth, the solution of tin is exceedingly difficult. The stannous salts when formed are oxidized to stannic salts and stannic salts will break down almost at once to the insoluble oxide, cassiterite.

Thus tin, although it may go in solution, will be almost immediately precipitated. Experiments by J. P. Goldsberry in the geological laboratory of the University of Minnesota have shown that cassiterite and stannite are both practically insoluble in tenth-normal sulphuric acid and hydrochloric acid. Doelter observes that tin oxide is slightly soluble in water. This statement was found by Goldsberry to be erroneous. The method of determination would have detected one part in a million. At the end of one month, a tenth-normal sulphuric acid, in contact with stannite and cassiterite, showed only faint traces of tin dissolved. Tin is enriched but little by migration in its deposits, because of the hydrolysis of its stannic salts which, as above stated, are precipitated as the insoluble oxide.

GOLD is not infrequently found in talc and serpentine. In these rocks it occurs in plates as thin as gold-leaf. It is extremely deceptive as to its quantity, rock supposedly rich in gold, judging by the amount in sight, sometimes assaying only a dollar or two per ton.

COPPER BARS to the value of $10,801,118 were invoiced at the American consulate general at Valparaiso, Chile, for shipment to the United States in 1916, as against $3,575,889 for 1915.

[15] T. M. Broderick: 'Some Experiments Bearing on the Secondary Enrichment of Mercury Deposits,' *Economic Geology* (1916), 11, 645-651.

A CONTACT-FISSURE CONTAINING WOLFRAMITE ORE.

TIN AND TUNGSTEN MILL AT HILL CITY.

Tin and Tungsten in South Dakota

By John Bland

The little town of Hill City, South Dakota, is again enjoying the uncommon American experience of a tin boom. The first boom came in the middle 'eighties and bled two continents to the extent of seven and a half million dollars, the pocket-books of the poorer people of England on one hand, and on the other the more fortunate possessors of tin-bearing ground embraced within the 15 miles square around the base of Harney Peak, the summit of the Black Hills. Millions were expended for claims, but little for mining.

The second boom has been created by the Hill City Tungsten Production Co., which began operations in May 1916. It entered the field in consequence of the tungsten boom, but remains on account of the high price of tin. A history of a legitimate attempt to produce tin in America would be interesting, and the double feature of tin and tungsten recovered in the same mill gives the enterprise, with its bi-metallic basis, a strong bid for stability. Tin and tungsten in the same mill is not unusual. Cassiterite and wolframite are commonly associated in nature. Each has a specific gravity of 7.1, and they are of nearly equal friability and hardness. A flow-sheet designed for tungsten of the Hill City variety is well adapted to saving the local tin, except that retreatment to produce clean concentrate is not so necessary for tungsten as for tin, nor does the less value of the tin concentrate warrant treatment of the middling.

The tin ore is low-grade, and no important orebodies have been yet exposed. The mine from which ore for the past three months has been taken was completely developed by the old Harney Peak Tin Co. This development work, together with the mining machinery installed by the old company, has proved fortunate, because the orebody ranks as commercial only because the cost of the full development work, including equipment, does not have to be incurred in its extraction. It is a remarkable coincidence that the activities of the old Harney Peak Tin Co. should have exposed this, the best of the orebodies revealed in their expenditure of $7,500,000. It is, moreover, only a little vein, which will not yield the cost of development work, plus that of extraction and concentration, even now with tin nearly three times as high in price, not to mention the higher recovery and the lower mill-cost at present obtaining. So it cannot be said that tin production has proved economical in the Hill City district, despite the fact that money is there being made in the exploitation of a tin orebody. However, it is true that excellent prospects exist, yielding a mica by-product that contributes to their profitableness.

THE COWBOY OREBODY, which has supplied the Hill City mill for the past three months, consists of the following underground workings: A single-compartment working-shaft 300 ft. deep, and drifts averaging 70 ft. long from the 60, the 100, the 200, and the 300-ft. levels. The Hill City company has stoped out much of the orebody above the 60-ft. level. The ore is cassiterite in quartz; the crystallization is coarse, and occurs mainly in small seams of mica in the quartz. The whole orebody assays 1.6% metallic tin. It averages about 30 inches in width, and about 5000 tons is exposed. The company found the shaft recently re-timbered, the shaft-house, hoist, and boilers in good condition, and underground development work as stated above; so that the

only expense in preparation for mining consisted in the addition of a compressor and the building of a 60-ton bin. The ore is hauled one and a half miles down the old railroad-spur grade built by the Harney Peak company, to the loading-platform at Hill City, whence it is hauled in 50-ton cars on the C. B. & Q. railroad to the storage-bunker above the mill. The transportation cost of 75c. per ton includes the flat rate of 25c. by rail, plus 50c. per ton by wagon to the loading-platform. The concentrate averages about 53%, and is reduced to metallic tin in a reverberatory furnace of 1½ tons daily capacity. The recovery is about 85% of the metallic tin. The loss of 15%, together with the high operating cost, has induced the company to enter into a contract for the sale of the concentrate to the American Smelting & Refining Co., for treatment at Perth Amboy, New Jersey.

Hill City Mill. This plant is installed in the old mill-building constructed by Fraser & Chalmers for the Harney Peak Tin Co. in 1893, at a cost of $250,000. The extraordinary strength of the materials used, the character of the great masonry foundations, and the site of the building, with its 11 floors, account at once for its great cost, and for its excellent state of preservation, as found by the Hill City company 23 years after its erection. No deterioration was found except in some damage to the roof and the broken window-panes. An 800-ton six-compartment storage-bin was built under the end of the railroad-spur, which was re-laid with steel for a quarter of a mile from the main line of the Hill City-Keystone branch of the C. B. & Q. railroad. Cars bringing ore from the Cowboy tin mine, and tungsten custom ore from the Lead-Deadwood district, dump into the bin. The ore is then trammed into the head bin above the crusher, thence passing through the mill as follows: 1½-in. grizzly, 11 by 14-in. jaw-crusher; trommel, 36 by 16-in. Chalmers & Williams rolls, trommel, 30 by 14-in. Allis-Chalmers rolls, Vezin sampler, sample to coffee-mill grinder, reject to 60-ft. elevator. The elevator delivers 96% through ⅓-in. ring, dry-product, to a 150-ton bin, which serves to make the crushing and concentrating departments independent of each other, the crushing machinery being designed to run one shift to supply the concentrators for three.

Ore is fed from the intermediate bin to three trommels in series; oversize from the first (running from 3 to 5-mesh) to Harz jigs; from the second (5 to 8-mesh) to Harz jigs; from the third (8 to 16-mesh) to Wilfley tables, undersize to cone-deslimer, oversize to 80-mesh duplex Callow screen, from which the undersize goes to a Deister-Overstrom table, while the slimer, 16 to 80-mesh oversize, passes to Bunker Hill screens, which split the feed into 16 to 24, 24 to 40, and 40 to 80-mesh sizes for Wilfley tables. The deslimed feed goes to the rag-plant.

The jig-middling is re-ground in 30 by 40-in. Allis-Chalmers rolls, the product from which is elevated to the first trommel, rejoining the ore-stream at its beginning. The middling treatment was designed for high-grade custom ores from the Lead-Deadwood district, as follows: middling from jig to rolls, middling from all other tables to a storage-tank above the desliming cone. The middling from the 8-mesh down to slime is re-passed through the screens for re-sizing. The middling obtained in re-running the original middling is re-ground, the coarse sand going to a National disc-pulverizer and the finer sand to a 4-ft. ball-mill. This treatment was designed, also, for the 'dike' tungsten ores, which are described later. This flow-sheet shows close mechanical sizing, instead of water classification, and also a complex treatment of the middling.

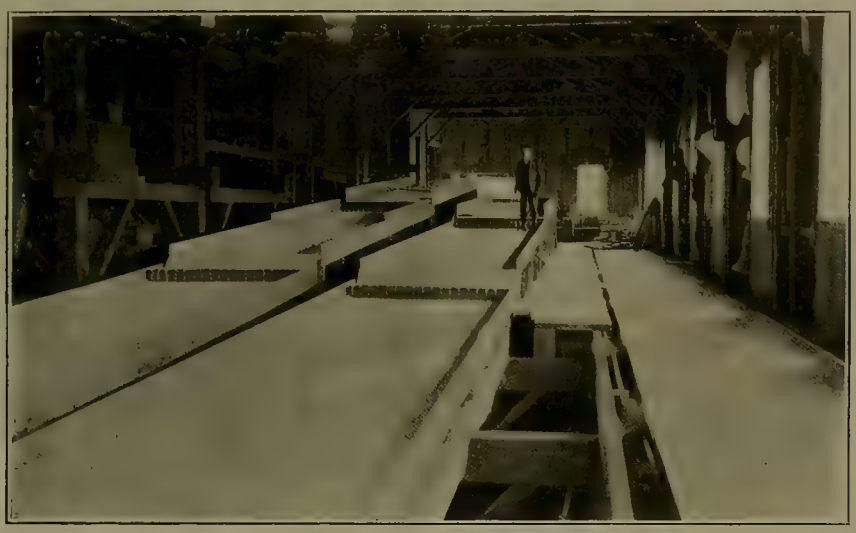
Two months' pilot-mill experimentation in the old Black Hill tungsten-mill proved the advantage of close sizing and separate-middling treatment. Tungsten milling involves all but a new principle in gravity-concentration: that of producing clean concentrate. The extremely high penalty for insoluble in the concentrate warrants unusually expensive treatment to avoid it, and the close sizing of ore and middling was found to be indispensable in securing this result. Sliming must be avoided for the same reason. That accounts for the attempt to secure the greatest possible size of concentrate-particle, and for screening before each crushing in order to remove ore needing no reduction in that unit. The rag-plant, through which all the sand passes before reaching the tailing-dump, has been found indispensable here as it is in the Boulder district, Colorado. A one-cell flotation unit has been installed for experimentation on cassiterite, wolframite, and hübnerite.

Though the tin potentialities might some day seem to have justified so large a mill, and the tungsten custom-business even more surely, the reason for so large an equipment with so little indicated ore demands explanation. Although designed to treat 150 tons of tin ore daily, the construction cost less than most 30-ton mills. The building was practically a gift, including the pumps, jigs, elevators, trommels, engine, and many other things. The crushing and power machinery were brought from an abandoned gold-mill not far distant, and the Wilfley tables were bought at one-fifth of the standard price. No trouble has been experienced with the second-hand equipment. This buying was possible, in a year when new equipment was almost unobtainable, because no metal mines other than gold exist within 400 miles of Hill City, and abandoned gold-mills, many with good equipment in them, are as thick in the Black Hills as warts on the back of a toad.

Tungsten custom-ores constituted half of the basis of the operations at Hill City. The two other tungsten mills in the Black Hills, that of the Wasp Gold Mining Co. at Deadwood and the Homestake at Lead, are closed to custom business. Prior to July 1916, the Wasp had produced $300,000 in tungsten concentrate from two Wilfley tables in its cyanide-annex, and the Homestake has been shipping a carload every four or five weeks for many months, dressed in a 20-ton mill. The Homestake deposit is, probably, the best tungsten orebody yet reported in the United States.

Excellent tungsten prospects are being developed in this district; they will soon be ready to ship to the Hill City mill, which is now being prepared to receive them. The Lead-Deadwood district, as proved in the cases of the Homestake and Wasp orebodies, bids fair to rival the Boulder and Atolia fields in richness, and unquestionably offers the best promise of large amounts of tungsten. The C. B. & Q. hauls ore direct from Lead-Deadwood districts to the Hill City mill, a distance of about 50 miles.

The Lead-Deadwood tungsten district has nothing in common, geologically, with the Hill City district. The orebodies are of different types: first, massive hübnerite associated with manganese in vertical shoots on quartzite contacts; second, as exemplified by the Homestake and Wasp orebodies, fine-grained and extremely disseminated wolframite in a quartzite gangue, the orebodies being flat beds associated with the gold ore of the Homestake lode.



THE RAG-PLANT FOR TREATING DE-SLIMED PULP.

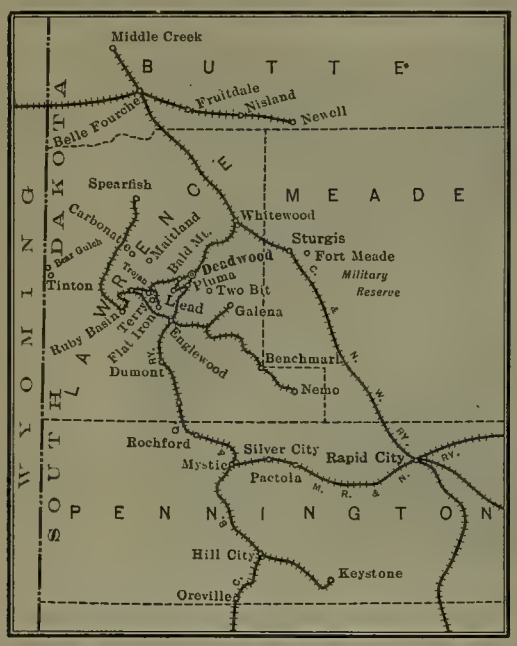
MINING DEVELOPMENTS. The single igneous intrusion that is important forms the Hill City district. Here Harney Peak caps the Black Hills, and ranks as the highest point east of the Rockies. The range is about 15 miles long, and from 2000 to 4000 ft. above the surrounding terrane. This granite mass and its associated pegmatite dikes is about 15 miles in diameter. The dikes fill fissures in the slate, rising from the same magma as the Harney range. Out of the dikes the quartz, mica, and rare minerals were forced into the adjacent slate, forming the quartz and mica veins of the region. Unfortunately, the main portion of the tin and tungsten remained in the dikes, concentrated, it is true, to ore along footwalls, quartz cross-veins, and faults, but not yielding concentrated vein-material such as is found in the Boulder district, Colorado. As great a total amount of tungsten doubtless exists in the Hill City district, but unlike Boulder county, the dikes are not barren and the veins rich. On the contrary, the dikes are the more attractive for prospecting.

The orebodies fall into three clearly distinct types: first, pegmatite dikes; second, true quartz fissure-veins; and, third, a distinct type of quartz vein, lenticular, with both ends of the vein in sight, and the bottom always reached at about the same depth as the length of the lens. No seams or fissures are found connecting these peculiar isolated lenses; no continuity of strike or depth has been observed. These lenses are either barren or contain tungsten only. None have been observed carrying any other metal except in one case, where wolframite occurs at one end and cassiterite at the other; the two minerals are unmixed; in fact, each is in a different colored quartz. These lenses have no commercial value, as they are never more than 100 ft. in length nor 2 ft. in width; nor do they carry more than 1.5% tungstic acid. A single exception is that of the Black Hills lens, which has recently been leased, with a 15-ton mill on the ground, to an operating company. This lens is of unusual size. A shaft 50 ft. deep shows a uniform widening from 16 in., at the surface, to 30 in. at the bottom, with a uniform content of about 1.8% tungstic acid. This type of ore is easy to concentrate, and, though small, the orebody is unquestionably profitable.

The second type of quartz vein is clearly distinct from the lens type. None of them carries tungsten, except one, which contains both tin and tungsten. This type of vein includes the Clara Belle, Holy Terror, and other gold mines, the Cowboy, Mohawk, Annie, and other tin mines. The Holy Terror yielded $3,000,000 in gold to the 800-ft. level, and the Cowboy tin mine is now being worked to the 300-ft. level.

No appreciable amounts of tungsten exist in these 'true' veins, except in the Annie. The Hill City tungsten is not in the veins but in the dikes, which constitute a prominent feature of the landscape. Rising above the

adjoining terrane 200 ft., in some cases, with their sheer sides heavily impregnated with mica, glistening in the sunlight, they are an interesting sight. The Harney Peak company sank an 800-ft. shaft in one of them, the Addie; a 500-ft. shaft in another, the Gertie; and many to a less depth. Unfortunately, they did not follow the ore-shoots, choosing a straight line, and we are therefore without proof of the continuity, in depth, of the tin and tungsten shoots. The tin ore-shoots in the dikes are, at the surface, from 50 to 200 ft. long, and extend across the full width of the dike, being richest on the foot-wall in most cases, but uniform in others. The best ore is usually accompanied by an increased mica-content, an important feature, as the shoots will average little more



MAP OF SOUTH DAKOTA.

than 1% in tin, and, at the present prices of tin and mica, the mica-content is worth half as much as the tin. With mica now saleable, and with tin at 45c. instead of 18c. per pound, with higher recovery, lower milling-cost, and a better understanding of the ore-shoots, the Hill City tin district does not now deserve the reputation left it by the Harney Peak Tin Co. twenty-three years ago.

The first recognition of tungsten in the Black Hills involves an interesting episode in the activities of the old Harney Peak Tin Co. Wolframite was seldom distinguished from cassiterite by the company's engineers. Proof of this is afforded by the many pits sunk by them on dikes that carry nothing but tungsten. Urged by reports from England of dwindling share-sales, the engineers hit on the idea of shipping an immense 'tin-stone' back home for purposes of inspiration. As previously stated, no single tungsten lens ever found in the region carries both tin and tungsten, with one exception, and they found that one. It is a queer orebody, with cassiterite at one end and wolframite at the other. They chose the wrong end, and a boulder, weighing more than a ton, with not a trace of tin, but full of wolframite crystals, went to the old country. Some skeptical investor broke off a piece and had it tested. No tin! This marked the end of the great adventure, with its millions of misspent money, for the report spread throughout England that the American Cornwall contained no tin, and no amount of persuasion could stay the effect of the rumor.

One hundred and eighty distinct mineral species have been identified in the dikes of the Hill City region. A fissure extending across a dike 150 ft. wide has been found filled with highly altered wolframite, with no accompanying gangue. This fissure, though small, widens in places to two feet, yielding valuable bunches of wolframite. The old Harney Peak company spent most of its money buying the 100 square miles embraced by the Harney region, at $1 to $40,000 per claim, so says tradition. However, some money was used in mine development, and while this argues little for the geologic knowledge of the Cornish engineers, the evidence of their timbering and the unvarying plumbness of their prospect-shafts prove their precision in executing right angles. Straight down through the ore-shoots go their shafts. That a prospect-shaft might follow the dip of the shoot rather than a plumb-line never appealed to them. Little is known, therefore, beyond promising surface indications on these dikes. Several prospects showing ore-shoots in dikes carrying 1.5% tin for 50 ft. in length, and more than 55 ft. in width, can be seen in the district. That these contain 20% mica, and that tin has steadily maintained a high price for some years, is good evidence that tin will some day come from the Black Hills in important quantities, for if these dikes prove workable, they will also prove practically inexhaustible.

LEAD FROM ITALIAN MINES. The lead-mining region of the island of Sardinia is known as the Mineral district of Iglesias. The argentiferous lead ore in Sardinia is composed principally of galena, and a small proportion of carbonate of lead. The production of lead ore for the whole of Italy and the figures for the Iglesias district during the past two years were: Italy, 41,590 metric tons in 1915; 43,538 tons in 1914. Iglesias district, 40,829 tons in 1915; 42,878 tons in 1914. These figures show a decrease of 2049 tons in the production of Sardinia during 1915, but an increase of 101 tons in other districts. It is not believed that this decrease is due to a scarcity of ore, as reports indicate that recent explorations show large deposits. The shipments of argentiferous-lead ore through ports of Sardinia in the season 1913-14 amounted to 34,300 metric tons. Of this amount, 18,582 tons was directed to the continent of Italy, 12,302 tons to France, 3036 tons to Greece, and 380 tons to Belgium.

THE QUICKSILVER output of the Almaden mines of Spain in 1916 was 27,102 flasks of 76 lb. each; in 1915 it was 36.000 flasks.

Patent 835,120

Herewith we give the story of the operations leading to the application for this patent as recorded in the Minerals Separation brief in the Miami Appeal before the U. S. Circuit Court of Appeals at Philadelphia. For obvious reasons we have not edited the text in any way.

During the year 1902 and succeeding years, and until March, 1905, when the process of the first patent in suit was discovered and invented, Messrs. Sulman, Picard, and Ballot were at work studying and improving the Cattermole metal-sinking process. Their investigations covered a wide range, including painstaking but futile efforts to utilize air and gases in flotation, but failed to develop during this period any procedure capable of taking the place of the Cattermole metal-sinking process. Occasional flotation of metal or failure of metal to sink in the Cattermole upcasts, was troublesome, as it meant, of course, that the metal which did not sink went to waste with the gangue, but nevertheless metal flotation was investigated, and the ingenuity of the inventors was applied to it, and it was tested and to some extent patented, and finally dropped as practically useless, except as a tail-end annex to the Cattermole metal-sinking process for the recovery in the final tailing of that process, by film or skin flotation, of a small fraction of metallic matter which the Cattermole process was unable to recover. This appears in the report of May 18, 1904, of Sulman & Picard to the plaintiff reporting the joint work of Messrs. Sulman, Picard, and Ballot, under the heading 'Clean-up of dirty sands.' This was their final solution of the utilization of flotation ten months before the discovery of the process of the first patent in suit, and all their further efforts were concentrated upon the improvement of the Cattermole metal-sinking process.

In July, 1903, Sulman & Picard invented the process disclosed in their patent No. 793,808. This process, although never developed to any utility, was patented, and the defendant puts this patent forward as its justification of infringement. In this process an effort was made to recover the metal by flotation as a metallic film on the surface of water of particles brought to the surface by air or gas bubbles and left floating at the surface by the bursting of the bubbles on their emergence from the liquid. The process was useless because the amount of oil used, Cattermole or larger proportions, was so great that the attraction of the air-bubbles for metallic particles was in fact destroyed, and what was actually utilized was the coherence of the oil-coating on the metallic particles to an oil-film on the bubbles, when submerged. This coherence was weak, unreliable, and in fact useless, and disappeared when the bubble reached the surface. It was thought to be the attraction of heavily oiled metallic particles for air or gas bubbles, and was therefore so described in patent No. 793,808. It was first tested by chemically generating gas in the pulp in the presence of heavily oiled metallic particles, and in this form was originated and tested by Sulman & Picard in July, 1903. In August, 1903, through the publication of the British patent to Froment No. 12,778 of 1902, they learned that this idea of floating oily flocks of metallic particles by bubbles of gas chemically generated had been anticipated by Froment. It was this circumstance which induced them to purchase the Froment patent and all improvements thereon for £225 sterling, or a little more than $1000, negotiations for that purchase having been commenced in August 1903, and the purchase completed in November 1903, when they still had hopes of developing something out of this flotation process.

Another form of this film-flotation process was the use of a slowly revolving worm immersed in the pulp to force air-carrying atomized oil into the pulp. This is disclosed in the Sulman & Picard patent No. 793,808 as the second method therein. This worm apparatus was experimented with in the laboratory, but not in accordance with the disclosure of the patent, since Mr. Chapman always used Cattermole sand containing metal particles already oiled.

Another flotation process produced while the Cattermole metal-sinking process was being developed was that which is disclosed in the Cattermole, Sulman, and Picard patent No. 788,247, known as the 'soap and flotation' patent. This patent is merely for the application to all that was known of the flotation of metals in 1903, of an operation wherein soluble soap is mixed with water of an ore pulp, the soap is decomposed by sulphuric acid and oleic acid precipitated throughout the mixture to coat the metallic particles, and after the metallic particles have been concentrated they are treated with an alkali to clean off the oil and to again form soap, which can be again used in the process. The process is referred to in the report of November 19, 1903.

The two preceding reports of May 5, 1903, and September 24, 1903, are entitled 'Cattermole Process' and limited to the work thereon. The first reference in the reports to any effort to utilize flotation appears in the report of March 4, 1904. These tests were incidental to the completion of an experimental Cattermole metal-sinking plant which Mr. Chapman took with him to Australia in April, 1904, for the purpose of testing it there and erecting there a large commercial plant to carry on the Cattermole process. The experiments are described in the report under the heading 'Flotation Factor Used,' but it clearly appears that what was thus described as flotation was merely the upward movement of thickly coated oiled metallic particles in suspension in an up-current of water in an upcast as a tail-end treat-

ment for the recovery of a very small fraction of the metal in the tailing. Two tests are thus described, and in the last run, No. 4, chemical generation of gas was tried, but the "concentrates obtained 1.6%" of the metal originally in the ore were not encouraging. We therefore find that in the next report, dated April 19, 1904, four days after Mr. Chapman had sailed for Australia taking with him the experimental Cattermole plant, further work on a duplicate of that plant was supplemented by vanning experiments, and chemical generation of gas was tested therewith, and modifications of shaking tables were devised, and finally on May 18, 1904, we find the climax of all flotation work prior to the discovery of the process of the first patent in suit in the following statement under the heading 'Clean-up of dirty sands:'

"This work gives considerable promise of early success. As foreshadowed in our last, we have converted the small model vanning table into a 'bumping' table, and have removed the riffles. By this means on small samples of dirty sands we have been able to clean up nearly all the contained oiled mineral, and to produce sharp clean sands without the use of any gas-producing carbonates, etc., thus effecting considerable economy both in acid and carbonate. Under these conditions mere contact of the oiled particles with air when exposed on the surface of the table is sufficient to insure their flotation removal from the sand."

This marked the final perfection of flotation as developed prior to the wonderful discovery made in March 1905.

This skin flotation produced by exposing the metal particles to air and then permitting them to float by surface tension was actually used in the Cattermole plant erected in Australia and the Cattermole plant, with a capacity of treating 100 tons a day of 24 hours was completed and started in operation in April 1905. The oil consumption, however, alarmed the mine-owners, and the plant, after running for a few days, was changed over so as to spoil the Cattermole process and make all the recovery on the skin flotation tables. This occurred after the discovery of the process of the first patent in suit, but in ignorance thereof, as will later appear.

The discovery was made in the week between March 3 and March 10, 1905. The work of the laboratory for ten months had concerned only the Cattermole process. A Cattermole plant capable of treating 100 tons of material per day was in process of erection at Broken Hill, Australia, and the work in London was for the purpose of acquiring information which would be useful in carrying on the Cattermole process. It had been found that heat assisted this process. It had been found in the laboratory that a single-stage agitation reduced the oil consumption down to the lowest point that it ever reached in the Cattermole process, to wit: 1.5% of the ore and a very comprehensive investigation was being carried on of the influence of seven factors "on granulation." Six of these subjects of investigation were the essential factors which contributed to the discovery. These factors are classified by Mr. Ballantyne, and are as follows:

(1) Agitation and aeration such as was obtainable in the Gabbett or cone-mixer,

(2) The use of oleic acid in place of the emulsions which characterized the earlier Cattermole work,

(3) Heating of the pulp,

(4) Fine crushing without desliming,

(5) Reduction of the quantity of oil, to be continued regardless of results, and the experiments fully reported,

(6) Acidification of the pulp.

When these factors were assembled and the quantity of oil was reduced step by step to the lowest limit, and the work was carefully, accurately, and thoroughly done, we now know that the discovery of the process in suit was inevitable.

Arthur Howard Higgins carried on these experiments under the direction of the inventors. He testifies as to having received instructions to carry out these experiments, and that these instructions were to start with "the upper limit of Cattermole's specified quantity, and reduce this as far as possible. In other words to find the lowest limit at which results could be obtained by the use of oil." Contrasting these investigations with his earlier work, he says as to this earlier work, that the quantity of oil "was always adjusted to give good granulation," and further:

"Q44. In adjusting the oil to give the best granulation, I presume you experimented with different quantities of oil?

A. Yes, there may have been different quantities, but whenever the granulation became imperfect by reason of the drop in the quantity of oil, the oil was naturally increased."

Three sets of documents written at the time record the discovery. They are the reports of Messrs. Sulman & Picard, the reports of Mr. Higgins, and the weekly letters of Mr. Ballot to Australia. First we have the Higgins report of March 2, 1905, and the Sulman & Picard report of March 3, 1905, describing the investigations up to this date and the scheme thereof with no mention except of granulation. Then the Higgins report of March 16, 1905, detailing the crucial experiments and announcing the result. The opening statement of this report is

"The effect of diminishing the percentage of oleic acid is to alter the type of oiling; the higher percentages producing granules, and the lower ones froth."

In the carefully tabulated description of experiments we find that with oil "0.32% on ore," the "float vastly increased," and that with oil "0.1% on ore," again the "float vastly increased." Experiments were tried with one-tenth of 1% of oil, and variations of the time of agitation, 4¾ minutes, 8 minutes, 12 minutes, and 10 minutes, and the last experiment with "0.5 cc. oleic acid" (one-tenth of 1%) and 10 minutes agitation, was selected for analysis, and the froth-concentrate was found to have recovered 87% of the metals.

The weekly letters of Mr. Ballot to Australia are only

copied in the record so far as pertinent. On March 3, 1905, Mr. Ballot wrote sending copies of the Sulman & Picard report of March 3, 1905, and the Higgins report of March 2, 1905. On March 10, 1905, six days before Mr. Higgins' report of the discovery, Mr. Ballot wrote as follows:

"I am pleased to tell you that during the week we have made some very important discoveries which will, I think, almost revolutionize our processes by way of simplifying and cheapening the same. I hope that by next mail the work will be sufficiently far advanced to send you full particulars. Several points have yet to be determined, and the discoveries are of such a nature that we have decided to take our expert and counsel's opinion thereon with a view to assuring ourselves that we can get good protection under patents. I may mention for your private information that we do not use more than 0.1 per cent of oleic acid per ton of ore and although we have not assays out that the recoveries will be very satisfactory."

This is the earliest document describing the invention, and fixes the date of invention as between March 3 and March 10, 1905. It shows Mr. Ballot's full knowledge and appreciation, and that patenting was even then under consideration.

One week later, on March 17, 1905, Mr. Ballot wrote, giving a remarkably full description and enclosing a copy of Mr. Higgins' report of the day before "received this morning." Every feature of the invention is accurately described. The only advantage of the invention that Mr. Ballot did not then know was that when the oil consumption "was reduced to a vanishing point, being only 0.1% per ton of ore treated," as he accurately says, it is not physically evident upon the concentrates and the concentrates may be subjected to subsequent physical treatment for separation into their constituent metals without washing off the mere trace of oil coating them. This was not necessary at Broken Hill, although the concentrates contained zinc, lead, and traces of silver. It was later demonstrated at the Saxbergets mine in Sweden, where the concentrates from the froth were subjected to magnetic separation and shaking-table treatment to separate iron, zinc, and lead. If, however, the concentrates are to be subjected to subsequent chemical treatment, as by cyanidation, the trace of oil must be washed off, as can be easily done with alkali, as suggested in Mr. Ballot's letter and in the patent.

The evidence as to instructions to Mr. Higgins, aside from his own frank statements above noted, is full and complete. William H. Ballantyne, the British patent agent who prepared the patent application was frequently consulted and was fully advised as to the Cattermole researches. He testifies as to the assembling of the factors, the drawing up of the series of tests, the declared intention to "reduce the proportions of oil to a vanishing point," and the disclosure to him on one of the days between the 8th and 15th of March, 1905, by Messrs. Sulman, Picard, and Ballot, of "their startling discovery of the agitation-froth process," and described a demonstration made to him early in April, 1905, which, with his full knowledge of all that had been done before, he regarded as "little short of a miracle." He also describes the diligent following investigations resulting in the production of the continuous apparatus shown in the patent.

This brings us to the Sulman & Picard report of May 3, 1905, reporting the work done up to that time in working out "the new method of oil concentration in detail for forwarding to Australia." This report says:

"In determining the lowest limit of oleic acid which could be employed in granulating, it was found that granulation practically stopped at a range of about 0.5% of oleic acid on the mineral [ore] (60-mesh Broken Hill) in an acid circuit somewhat below 1% in strength. A certain amount of black mineral-froth was, however, noticed as a result. On successively decreasing the amount of oleic acid below 0.5%, it was found that whereas granulation ceased there was a growth in the amount of mineral float-froth under these conditions, and that the production of such float-froth appeared to reach a maximum when about 0.1% of oleic acid on mineral was used. This froth on collection was found to consist of oiled mineral slimes mechanically holding more or less coarse (oiled) mineral particles, the froth carrying between 70 to 80% of the total mineral present in the charge. The gangue-slime and the coarse sand are left quite white in the liquor below the froth, and the balance of the coarse mineral not caught up in the black froth, but remaining fixed with the sand, is found to have been efficiently oiled, and to be capable of complete recovery from the sand by table aeration."

With the slight correction noted in the bracket, this exactly sums up the newly discovered process as applied to Broken Hill ore with oleic acid as the oil.

Then follows a statement describing investigations which satisfied the inventors that the froth was due "to the air introduced by the Gabbett cone during agitation," that the production of froth was to some extent dependent upon "the amount of mineral slimes present and the fineness of the grinding," and that heat and acid were necessary in these operations.

The continuous plant was fully described, and was shown in a drawing made by Mr. Sulman and annexed to the report and all the methods of supplemental treatment referred to in the patent are described.

A copy of this report and its drawing were immediately sent to Australia, as appears from the memorandum on the report 'Copy sent to C. F. Courtney and Geo. A. Chapman 5/5/05—May 5, 1905,' and a similar memorandum on the drawing. Mr. Chapman testifies to receiving in June, 1905, instructions from Mr. Courtney, to whom all of Mr. Ballot's letters had been addressed, to change the Australian plant to take advantage of the discovery, and to receiving a drawing which he particularly identifies as a copy of the drawing attached to the report of May 3, 1905, and says:

"Owing to the trouble which had been met with in working our previous method, as a practical man, I was

very much gratified and relieved to know that we could substitute this more simple and ingenious process."

This marked the commencement of the commercial use of the invention, which will be hereafter referred to under that heading.

It may be noted generally as to the reports in evidence, prepared merely for the records of the company, the only remarkable fact is that they contain as much information as is contained in them. Very many subjects are only touched upon in the reports. For example, in the Higgins report of March 2, 1905, it is stated that during experiments directed by Mr. Sulman to determine the rate of change of granulation with temperature, the influence of other conditions was sufficiently marked to suggest their improvement, and that these conditions have been carefully examined but nothing identifiable by the reports alone further appears as to these other conditions. Mr. Higgins testifies as to these other conditions, which are evidently of no importance in this controversy, although one of them, as to the relation of the size of the revolving cone to the size of the vessel in which it revolves, is referred to at the end of Mr. Higgins' report of March 16, 1905.

Again, comparatively little appears as to the investigations of the Froment process and the process of patents No. 793,808 and 788,247, but this merely shows how relatively unimportant these useless flotation processes were. As Mr. Higgins says of his tests of the Froment apparatus in May or June, 1904:

"At that time a good many failures were only reported orally."

It is plainly apparent from the reports that up to the time of the discovery of the process of the first patent in suit, the one reliable process of ore concentration of Minerals Separation, Ltd., was the Cattermole process, and that after the discovery of the process of the first patent in suit the Cattermole process disappeared.

FLOTATION AT COBALT. The flotation plants at Cobalt generally use a mixture of pine-oil, coal-tar creosote, and coal-tar. A mixture of 15% pine-oil, 75 coal-tar creosote and 10 coal-tar is efficient. A 10% pine-oil and 90% high-sulphur fuel-oil mixture is used to float cyanide tailing with fairly good results. A chloridizing roast, followed by leaching either with cyanide or with an acid brine-solution has given the best results. The Buffalo mine is now treating 5 to 6 tons of flotation-concentrate per diem by a chloridizing roast, followed by an acid leach to extract the base metals, and then by a cyanide leach to recover the silver chloride. A 95 to 98% extraction of the silver has been obtained with this method. —Bull. Can. Min. Inst.

FLOTATION has been applied both to ferberite and to scheelite. The tungsten in the ore at Nederland, Colorado, is present chiefly as the iron tungstate, ferberite. Experiments with flotation on this material have not proved economically successful, owing to the fact that the associated valueless iron minerals also float readily.

Fixation of Nitrogen as Cyanide

*The earliest attempt to produce cyanide of soda by a reaction in which atmospheric nitrogen was directly fixed in the compound was by Lewis Thompson in 1839. His method consisted in heating for a period of half an hour, at a temperature of about 900° C., an intimate mixture of potassium carbonate (pearl ash) two parts, coke two parts, iron turnings one part. On leaching the cinder potassium cyanide was found to have been produced, which he converted into Prussian blue. A later attempt by Newton to produce cyanide directly by fixation of atmospheric nitrogen failed because of the necessity of operating at an elevated temperature, and also because he had not recognized the function of iron in the reaction. Prof. John E. Bucher of Brown University has recently investigated the subject further, using a ½-in. malleable iron pipe 30 in. long, enclosed in a larger horizontal pipe, so that the inner pipe might be surrounded with hydrogen or with nitrogen to prevent fusion of carbon di-oxide in the inner tube. He succeeded in fixing atmospheric nitrogen by first filling the inner tube with lamp-black and heating to a white heat in a current of hydrogen; sodium was then placed in one end of the tube and nitrogen passed through and allowed to bubble through water in a flask at the other end. The reaction is expressed by the equation $2Na + 2C + N_2 = 2NaCN + 46{,}200$ calories. The fixation of the nitrogen was very slow, but the addition of finely divided iron resulted in a sharp increase in the rate of absorption. Following these experiments sodium carbonate was used instead of metallic sodium; a mixture of graphite, iron, and sodium carbonate was heated in the inner tube in a current of nitrogen to 920 to 940° C., when 60% of the sodium carbonate was converted into cyanide. This showed that Thompson's original claim that iron is necessary was correct and that subsequent failures with the process had been due to its omission. The function of the iron is catalytic. To render the process commercially practical Prof. Bucher has briquetted the mixture, which is dried until hard. The iron used was derived from iron-scale ground to 100-mesh in a ball-mill. The coke was next added, followed by the soda-ash. In the form of briquettes the charges put through yielded 28% of sodium cyanide when finished. Instead of using nitrogen, air was employed after passing it through hot coke, fixing the oxygen as carbon monoxide. The air thus prepared was successful. It was found that the reaction was most complete when only 20% of soda ash was present in the briquette. An increase beyond that point caused an actual reduction in the amount of cyanide formed. In practice the process is now conducted in vertical retorts, employing producer-gas for heating as well as for supplying the nitrogen. Ashless carbon is necessary as the ash from the coke accumulating with each repetition finally stops the process.

*Abstract: *Met. & Chem. Eng.*

Nevada's Latest Gold District

By Fred. J. Siebert

The camp of Olympia (which name must be changed on account of post-office objections) is situated 25 miles north-easterly from Mina, Nevada, in Mineral county, near the Nye county-line and at the extreme northerly end of the Cedar Range of mountains.

The principal claims, nine in number, were located in January 1915 by James P. Nelson, a prospector of many years' experience, and the most able, hard-working, and conscientious prospector I have ever known. Nelson named them the Royal George group. The ground had been located many times before but the rights had been allowed to lapse. In the higher hills there are many showings of quartz-veins in a later flow of rhyolite, which capped, to some extent, the older flows of rhyolite, andesite breccia, and biotite andesite. These veins strike east and west, and what little ore is contained in them seems too spotty to be profitable, so far as they have been developed. It was not until May 1915 that Nelson, after most careful prospecting, found on the Royal George No. 4 claim the obscure outcrop of a vein striking north-west and south-east in the older underlying rhyolite, near the base of the hills and dipping under them. By careful panning and sampling fresh signs of this vein were found for about 200 ft. along the strike. The actual outcrop was found in only two places about 65 ft. apart and assayed from $15 to $90 across an average width of about 7 ft., the assays running in the ratio of one ounce of gold to one and one-third ounces of silver. This vein was heavily capped to the south-east by Siebert Lake-beds,* which cover large stretches of the country below the elevation of the camp, 5975 ft. above sea-level. North-west the vein was covered by occasional patches of lake-bed, soil-wash, and laterite. After the strike was made known the usual trouble with claim-jumpers was gone through, and the absurd demands of our mining laws appeased through the usual 'cash' channel through the attorney's pocket. The ground was then purchased from Nelson by the Olympic Mines Company, a close corporation owned largely in San Francisco. Prior to this, development work was started by a partnership of four men who held a bond on the property. This development consisted of a shaft inclined with the vein at a dip of 43° to the 150-ft. level, where the vein turns off flatly, the shaft continuing on the same dip to a depth of 225 ft. and of levels at 100, 150, and 200 ft., besides cross-cuts, raises, and winzes, the total development amounting to date to about 2000 ft., most of which is in ore. In so far as the vein-bearing formations are concerned, practically all of the surface is totally obscured either by lake-beds, soil-wash, laterite, or flows of later rhyolite and andesitic breccia. At one point on the strike of the vein and 930 ft. south-east of the shaft, remnants of outcrops are found imbedded in a hot-spring deposit that shows gold quite plentifully by panning.

Underground, four different rock-flows are found, all of which dip north-east at about 20°. The vein is a fissure crossing the oldest flow of rhyolite until the 150-ft. level is reached, where in places andesitic breccia forms the foot-wall. Usually, however, the vein is wholly within the rhyolite and for some distance only a few feet of rhyolite intervenes between the foot-wall and the underlying andesitic breccia. The workings disclose a strong, well-defined, normal fault striking north and south, and dipping east at an angle of 50°. This fault has had a remarkable effect upon the shape of the vein, as this sketch will show.

MAP OF A PART OF CALIFORNIA AND NEVADA.

As the strike of the vein is N 40° W, and the strike of the fault N 7° W, the vein is synclinal in form, with the axis of the syncline coming to the surface toward the north-west, where it forms a junction with the fault and the vein. Toward the south-east, however, the syncline becomes deeper and the vein has much greater extent between the surface and the fault. One would naturally expect that from the point where the vein turns to an almost horizontal position, and up to the main line of faulting, there would be a great number of

*Named by Spurr, U. S. Geol. Sur., Prof. paper No. 42, 1905.

minor faults parallel with the main fault and also a broken condition of the vein, but no such condition exists. There was no hint of the fault until it was actually encountered, which seems to prove that the fault was very slow-moving, and the rocks in a plastic condition. From underground observation it would seem that this fault was contemporaneous with vein-formation. Evidently, however, the movement along the main line of faulting continued after vein-forming action had ceased.

Development work on the foot-wall side of this fault has not proceeded far enough yet to find the other end of the vein, but it has proceeded far enough to prove that the throw is over 60 ft. It is quite probable that a portion of the vein toward the north-west has been entirely eroded, but in a south-easterly direction the hills

RELATION OF VEIN TO FAULT.

rise to a considerable height and the south-westerly extension should be found there, if there ever was any extension. The vein originally was calcitic, but has been entirely replaced by quartz, leaving only the form of the calcite crystals. The vein-filling consists of solid white quartz and adularia with branching stringers into the soft wall-rocks as the limits of the vein are reached. The average width of the vein is about 7 ft., and the average value about $23.50 in gold and silver. No evidence exists in the oxidized vein of any base metal other than a small amount of iron and manganese. The richest ore is chalky white, with no sign of mineralization. The gold is finely divided and evenly disseminated. It resembles the ore of the Gold Roads district in Arizona, while the enclosing rhyolite closely resembles the rhyolite at Jarbidge, Nevada. It is coarse-grained with large quartz phenocrysts, has a greenish color, and is well leached near the vein, particularly on the hanging-wall side.

Extensive tests prove that the ore is readily amenable to cyanide treatment after being ground to 200-mesh. An extraction of 98.2% was made by actual mill-test after 6 to 8 hours' treatment. A mill of 70 tons daily capacity is now being completed and is expected to be in operation early in April. Water has been piped 6 miles from an elevation 1500 ft. higher than the mill, which is placed near the collar of the shaft, a low trestle connecting them. The mill is equipped with a 190-hp. Allis-Chalmers horizontal Diesel engine, which will be operated on 24° B. oil hauled from Mina, Nevada. Hendy crusher, ball and tube-mills; Dorr classifier, thickeners, and agitators; Oliver filter; and Merrill precipitation equipment constitute the plant. The assay-office and refinery are housed in the same building with a dust-tight partition between. This building is about 300 ft. from the mill and the pregnant solution is pumped up to it, the barren solution returning by gravity to the mill-supply tank.

The mill conforms in every way to ordinary up-to-date cyanide practice, the only extraordinary equipment being the Dorr classifier, which is 6 by 22 ft., and three Dorr thickeners, each 32 by 12 ft. Owing to the colloidal nature of the ore, a large settling-area with a dilution of about 10:1 seems advisable in the classifier, and for the same reason 30 sq. ft. settling-area per ton per day has been provided in the thickeners.

STRONTIUM is in more active demand at the present time than for many decades. The sudden increase in its use is due to the need of the brilliant red color in signaling with fires, rockets, and the like; furthermore, the oxide is employed in the extraction of saccharine matter from beet sugar, an additional recovery of 6 to 8% being obtained by this method over the results by the older processes. Germany and Russia each use about 100,000 tons per annum of strontium hydroxide in the sugar industry. It is adapted to a like use in refining cane sugar. The more desirable strontium mineral is the carbonate (strontianite), but the sulphate (celestite) is more abundant and can be sold in large quantities at about $12 to $14 per ton at the Atlantic seaboard. Celestite occurs to some extent in limestones and sandstones of Ordovician and Silurian age; occasionally also in similar rocks of later times. It is often found associated with deposits of gypsum, and is not uncommon as a gangue mineral in lead and zinc ores. Strontianite is likewise found in limestones, but more frequently in veins as an associate with barite, calcite, and pyrite. In many fluorite deposits it also appears, especially when barite is also one of the associated minerals.

LORENZO SUNDT, writing in *Economic Geology*, attributes the formation of sodium nitrate in the Chilean desert of Tarapacá, to the nitric acid present in minute quantities everywhere in the atmosphere. No electrical theory is required. The soda necessary for the reaction with the nitric acid is derived from the decomposition of the feldspar in the rocks. The reaction is rendered possible by the fogs which form along the front of the Andean range.

WHERE a machine can be run direct by a dynamo it should be done. It not only does away with the first cost and the subsequent wear and tear of a belt, but also it relieves the main shaft of a severe side strain and consequent friction.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

NATIVE ANTIMONY is not uncommonly associated with stibnite. It occurs near Corona in Riverside county; near Bodfish, and on Antimony mountain, in Kern county; and in Wild Rose canyon, in Inyo county, California.

HEMATITE is iron sesqui-oxide. It is not proper to say 'hematite of iron.' Limonite is brown iron oxide, the chief difference between limonite and hematite being the presence of water of crystallization in the former. Roast limonite and it becomes hematite.

BISMUTH has a curious effect on gold, when alloyed with it. One part of bismuth in 2000 of gold destroys the cohesion of the atoms of gold to such an extent that the alloy can be crushed in the hand. Pure gold has a tensile strength of 14,000 lb. per square inch.

IRON in solution in water may be detected by the addition of a drop of potassium sulpho-cyanide giving a deep red color if ferric iron is present. Then add a drop of potassium ferro-cyanide. If ferrous iron is present a dark blue precipitate will form in the solution.

ANSWERING an inquiry from National, Nevada: a person who is not a citizen of the United States and who has not declared his intention to become one is not qualified to locate or hold a mining claim in the State of Nevada, nor in any other State where the United States land laws are in effect. Neither can an alien hold a mining claim that he has bought from a citizen locator.

AN EXPERIMENT made several years ago by the management of the De Beers mines in South Africa demonstrated that a cubic metre would contain about 1,167,000 carats of diamonds of various shapes and sizes, and that the lot would be worth about $75,000,000. Diamonds have advanced about 100% in value since that time, so a cubic metre of diamonds may now be appraised at $150,000,000.

THE FIRST tangential water-wheels made were those introduced in early days in California and were known as hurdy-gurdy wheels. They were rude in construction, without the scientific lines that characterize those of the present day, but the old hurdy-gurdy wheels, nevertheless, were the most efficient means of applying water-power that had been devised at the time they were introduced.

POTASH is in growing demand, and this has stimulated the search for materials that will yield this salt. Desert basins have been prospected in the hope that a large and easily available supply may be discovered, but thus far with scant success, with the possible exception of the Searles Lake deposit in California. Some varieties of kelp have long been known to contain potash, and works have been erected at San Diego to treat this sea-weed in quantity to recover the potash. A discovery, made recently, that may be important, is that the stalks of bananas contain potash. The ash of a sample that was dried and burned contained over 10% potassium oxide, of which 74% was soluble.

TAILING from dumps of the East Rand Proprietary contained 1.71% sulphuric acid due to decomposition of mineral and salts during exposure to the atmosphere. This sand was to be used in filling old stopes, and as a large quantity of lime would be needed to neutralize the acidity, ash from boiler-plants was mixed with it, the whole being sent underground. The ash performs the function of a neutralizer and binder, and aids in the draining of the sand in the stopes. Transvaal coal, when burned, gives an ash containing 25 to 40 lb. of CaO per ton of ash.

AN EXPERIENCED MILL-MAN will feed quicksilver to the battery as it is required by the ore, and not in stated amount at a fixed time. The outside plates are always the best index as to when mercury should be added. The plates must be neither too hard nor too soft. Most millmen aim to keep the upper end of the plate as nearly normal as possible, the central part a trifle soft and the lower end rather harder than normal. Extremes must be avoided if good results are expected. The plates must be watched, and kept in good condition by dressing as often as necessary, not at a stated hour each day.

THE MORTAR of a stamp-battery, that has been unprotected by liners and has worn through, may be effectually repaired by securing a piece of steel plate to the outside of the mortar by means of bolts passing through both mortar and plate. It is never too late to provide a mortar with liners. They may be made of forged steel three-eighths to one-half inch thick and cut to fit the ends and back. Put the back liner in first, the end pieces holding it in place, these latter being secured to the ends of the mortar by bolts which pass through and are kept tight by nuts on the outside. If possible cut the back plate so that it may be turned end for end when worn, the good half being then where the worn part had been.

VALUABLE MINES are not confined to any particular altitude, as the following will show: The altitude of Leadville, Colorado, is 10,200 ft. above the sea at Harrison Avenue; Cripple Creek is about 10,000 ft.; Ouray 7710 ft.; Deadwood, South Dakota, 4530 ft.; Lead at 5300 ft.; Butte, Montana, at the Court House, is 5767 ft.; Boise, Idaho, is at 2739 ft.; Prescott, Arizona, at the Court House, is 5346 ft.; Bisbee is 5300 ft.; Jackson, California, is 1975 ft.; Salt Lake City, Utah, is at 4248 ft.; and Park City at 6222 ft.; Virginia City, Nevada, is 6339 ft. The Alaska Treadwell mines are at sea-level, as are numerous others in Alaska and in British Columbia, while there are valuable mines in the South American Andes, at 15,000 to 18,000 ft. above the sea.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

RICH STRIKE ON YANKEE HILL.—THE BOHN SHAFT TO BE RE-OPENED.—OTHER NEW DEVELOPMENTS.

A discovery recently made at the Silver King mine, on Yankee hill, promises to be one of the most important developments that has taken place in the district during the year. A 3-ft. vein of lead carbonate showing a quantity of silver chloride has been found on the third level, at a depth of 140 ft. in what is believed to be the white lime that underlies the parting-quartzite. The same formation has just been cut at the Jamie Lee shaft of the Leadville Unit on Fryer hill, about a mile to the west, at a depth of over 600 ft., showing that, if it is true that the white lime has been reached at the Silver King, there must have been an enormous upheaval or roll in the formations somewhere between the two properties.

The part of the district surrounding the Silver King has never been developed and the work now under way there is the first piece of important exploration ever undertaken in that territory. The early-day mining men of the district neglected the area because they believed that all of the chief ore-bearing formations of the upper contact had been scored off by glaciers. Present-day authorities on the geology of the territory repudiate the old theory, stating that the blue lime has been found in place in several parts of the hill. This fact, together with the finding of ore in the Silver King, supposedly in the lower contact, makes the Yankee hill area loom up as one of the most promising parts of the district. Should continued development at the Silver King show the lead-carbonate vein to increase in extent and remain rich in silver there is no doubt that the coming summer will see much activity at a number of adjoining properties.

In addition to the discovery of lead carbonate and silver chloride, an immense body of low-grade zinc carbonate has been uncovered in the Silver King and the Brady tunnel, adjoining. Development in these deposits has been under way for several months and a number of shipments have been made. The ore is stated to contain around 20% zinc.

The Bohn shaft, one of the old producers of the Down Town section has been taken over by a local company of lessees who will re-open the property and carry on extensive developments. The Bohn has been idle for about 15 years and the shaft is in bad condition from top to bottom. It is 580 ft. A new electric hoisting-plant has been installed and the work of re-timbering is now under way. The first level in the Bohn is at a depth of 440 ft. Large bodies of iron and manganese were extracted from the property through the first level when the property was last active. Bodies of rich lead and silver ore are also reported to have been found in the mine at one time. The new operators, in addition to opening large deposits of manganese, expect to find extensive bodies of carbonate of zinc—an ore that was not recognized in the district until after the Bohn had been abandoned.

The old Anderson tunnel, now called the Ohio tunnel, near Birdseye, is to be re-opened by a new Ohio company organized by C. H. Weaver and H. A. Huttinger, who, for the past year, have been interested in the property with the late W. B. Anderson. The entire stock has been transferred to the new company, which is financed to drive the adit an additional 3600 ft. into Prospect mountain. When operations were abandoned last autumn, following the death of Mr. Anderson, the tunnel had reached a point 1571 ft. from the portal. It is equipped with electric-trolley and haulage-system and the property in general is in first-class condition for operation. It is reported that work will be resumed within the coming month.

The Fanny Rawlins property, on Breece hill, is about to enter another period of heavy production, one of the largest orebodies ever found in the mine having been discovered on the second level where development has been under way for some time. The shoot, which carries an average value of $20 per ton, extends below the second level and has been exploited to some depth by a winze. A new drift on the third level will tap the ore, and as soon as this is completed, shipping on a large scale will be taken up. A small vein of 18% copper has also been cut in the new drift on the third level.

Patrick Mulrooney, owner of the Greenback property in Graham Park, is developing the mine after several months of pumping to drain the workings to the bottom level at a depth of 1350 ft. Station-pumps installed at the bottom and on the 900-ft. levels are handling the water. Large and rich bodies of sulphide ore are being exploited in the Greenback and a heavy output is being made. Shipping was started March 1, and up to the 20th, 600 tons of ore had been produced. The property is in shape for continuous operation and is expected to be one of the big mines of the district during the next few years.

The King Solomon Tunnel & Development Co., at Frisco, Colorado, is making elaborate preparations for resumption on a scale that will enable the property to become the heaviest producer in Summit county.

The Ontario, Tiger, and Green Mountain Leasing Co. rapidly is completing preparations to begin shipping from the shoot of high-level lead-gold ore recently encountered in the Ontario tunnel. New ore-bins have been built at the property and the road to the tunnel repaired for heavy hauling. It is reported that the first shipment will be made this week.

The ore-shoot is being developed above the tunnel level and continues as large as when first cut. Cross-cutting on the vein is also under way and other ore-shoots are daily expected.

There are approximately 115 properties in the district under development; of this number, 76 are producing and the others are either in the preliminary stage of activity or are undergoing extensive prospecting.

NEVADA

INCREASING SCALE OF OPERATIONS AT MASON VALLEY MINES.—EXTENSION OF PLANT PROPOSED.

The Bluestone mine commenced operations on November 20 last, shipping ore to the Mason Valley smelter at Thompson, by wagons to Mason, and thence over the Nevada Copper Belt railroad. At the same time the construction of three miles of standard-gauge railroad having a maximum gradient of 6% was commenced, together with the construction of one mile of electric haulage, joining up the main haulage-adit with the loading-terminal of the 3-mile standard-gauge spur from Mason. A compressor-plant of 2800 cu. ft. capacity was installed, motor-generator set, shops, office, and other buildings constructed. During the construction period of 3 months, 7000 tons of ore was shipped by wagon. Since March 1 ship-

ments have been going forward at the rate of 600 tons daily, and it is expected to increase this to 1000 tons daily by the last of April. Mining is carried on by the open-pit as well as shrinkage-systems, using Dreadnaught drills both mounted and as pluggers. Ore is dropped down through the main ore-passes to the 300-ft. or adit level, loaded into 5-ton side-tip cars of the Granby type, and hauled in trains of eight to the railroad loading-terminal. This terminal consists of a tunnel 180 ft. long into which two standard-gauge hopper-bottom steel gondolas are pulled by means of an electric-winch to two air-operated loading-chutes, the chutes being at the lower end of two raises 105 ft. long, which hold 300 tons each and into which the cars of the electric-haulage are dumped. The loaded ore cars gravitate out of the tunnel and onto the make-up track, and are hauled down the mountain to Mason by means of a Heisler geared locomotive.

It is expected that a concentration-plant will be erected during the summer to treat the lower grades of ores, of which there is a large tonnage. C. D. Kaeding is vice-president and general manager.

The smelter at Thompson is treating approximately 1000 tons daily from the Bluestone, Mason Valley, and Ludwig mines. As soon as the coke shipments are increased a second furnace will be blown in to take care of the increased tonnage from the Bluestone.

SUTTER CREEK, CALIFORNIA

PROGRESS AT THE BUNKER HILL.—AMADOR CONSOLIDATED MAKING HEADWAY.

E. Hampton, for many years Superintendent of the Bunker Hill mine near Amador City, has tendered his resignation to take effect on April 1, and at a meeting held March 15 by the directors in San Francisco, Chas. E. Bunker was appointed to succeed him. The bend in the lower part of the shaft has been straightened within the past two months and three crews of shaft-men are now replacing the decayed sets of timbers in other parts of the shaft with heavy new timbers. The 40-stamp mill is meanwhile crushing to full capacity; the rock from the lower levels in particular being above average value.

The shaft-crew at the old Eureka mine at Sutter Creek has reached the 1725-ft. level and, from now on, progress will be slower in clearing the shaft than heretofore, for the reason that instead of handling water only, it is necessary to remove the large quantity of sludge and rock that has accumulated in the bottom of the old mine during its long period of inactivity. The excess water caused by the recent storms is being handled by the pumps without difficulty and when the new hoisting-machinery is in operation and the larger skips can be put into use from the new head-frame, much better headway will be made in removing this débris. The installation of electrical machinery is almost completed. It is reported some very good ore has been found in the lower levels.

REPUBLIC, WASHINGTON

RENEWAL OF MINING ACTIVITY IN THE REPUBLIC CAMP.

The demand for Republic silicious ore is increasing and leads to the impression that considerable activity will result in that camp the coming summer. The Trail smelter has had P. E. Racey here the last 10 days; he has sampled the Mountain Lion mine and is now sampling the Great Republic mine. For several months a deal has been on for the sale of the Republic mine, and experts believe in the probability of ore of at least good shipping grade being found below the deepest workings, now 731 ft. lower than the outcrop. The rich ore-shoot feathered out at a depth of about 625 ft. A winze follows the vein 125 ft. below the No. 4 adit-level, and drifts both north and south on the 700-ft. level follow the hanging wall, from which cross-cuts were driven by the Republic Consolidated Gold Mining Co., but no payable ore was found at that depth. R. G. Edwards Leckie, who was then in charge, advocated the sinking of a vertical shaft to strike the hanging wall of the vein at a depth of about 1000 ft. I think D. C. Jackling favored Mr. Leckie's view, but the company was short of funds at that time. Transportation and treatment charges by the Granby company at Grand Forks, B. C., were then $7.50 per ton, and the reduction of more than one-half of that expense is of itself a good reason for renewed activity in development in the mines of Republic.

During 18 days 350 tons of ore has been shipped from the Tom Thumb mine, which is again under lease and bond, with E. J. Delbridge as manager. The new leasing company has acquired also an option on the Rebate mine, which adjoins the Tom Thumb on the south. On the Rebate an adit formerly was run about 400 ft. and considerable driving on a 5-ft. vein developed a large quantity of very low-grade ore, much of which may now possibly become available for the smelters under the present low rates of transportation and treatment. The present plan is to extend the Rebate adit about 200 ft. north to the Tom Thumb vein. The leasing company is employing 16 men on two shifts.

A contract for sinking 500 ft. on the Last Chance mine, owned by the Lone Pine-Surprise Consolidated Mining Co., has been finished. At a depth of 485 ft. the vein was first exposed in one corner of the shaft and now extends entirely across it, but its full width has not yet been ascertained. Two men are employed sorting the ore. The shaft will be sunk to 30 ft. below the 500-ft. level, for a sump, when a station and ore-pocket will be cut. An aerial tramway will be constructed from the shaft-house to a spur of the Great Northern railway, in Eureka gulch before any ore is shipped to the smelters.

The sinking of the double-compartment shaft on the Lone Pine mine 150 ft. deeper has been started by the Northport Smelting & Refining Company.

During the first week in March the shipments from Republic to the smelters were as follows: Northport Smelting & Refining Co., 540 tons; Knob Hill Co., 530 tons; Moye Leasing Co., 40 tons; Tom Thumb, 150 tons.

The Knob Hill Co. reports that the lower adit on the Knob Hill mine will be extended to the Mud Lake vein, which, heretofore, has not yielded any payable ore. A fine looking vein on this property was formerly developed on the Republic early-day plan of sinking shafts regardless of the whereabouts of a pay-shoot.

A rich streak of gray-copper is reported to have been recently discovered in the Lucille Dreyfus mine, near Danville, and an important strike of galena is reported from the Kettle River mine, at Rockcut, in Orient district.

SANTA FE, NEW MEXICO

MINERAL PRODUCTION FOR 1916 OVER $34,400,000.

New Mexico's mineral production increased more than $12,000,000 in 1916, according to the figures of the State tax commission, which are the only authentic figures available. Producers reporting to the commission show a total of $34,410,488.68, and a few concerns failed to report within the specified time. In 1915 the gross production was $22,489,000. The net value of the 1916 mineral output, as determined by the commission for purposes of taxation, was $17,248,630, an increase of $6,889,684 compared with the previous year, when taxes were paid on $10,358,946. Under the New Mexico mine-tax law producers pay on the net value, at the rate fixed for taxable property in general.

The big increase in the production of the Chino Copper Co. in 1916 was principally responsible for the increase in the gross and net totals for the year. The Chino reported a gross output of $19,219,767.18, as against $11,383,777.48 in 1915, and its net, as determined by the commission, was $12,600,293, as against $6,846,204.

In addition to the Chino, other copper producers reported

large increases. The Burro Mountain Copper Co., the Phelps-Dodge concern that started production late in 1915, had an output last year of $2,034,775.18, and took rank as the second copper producer of New Mexico, displacing the 85 Mining Co., notwithstanding the fact that the latter nearly doubled its production, reporting a total gross of $1,456,587.29, compared with $762,921.78 in 1915. The output of the Burro Mountain in 1915 was only $72,059.29.

The Stag Canyon Fuel Co. led the coal producers in gross output in 1916, but failed to show a net production as great as that of the St. Louis, Rocky Mountain & Pacific, which ranked second. The gross of the Stag Canyon was $2,903,-568.25 and its net $410,918, while the Rocky Mountain had a gross of only $2,284,239.80, but a net of $734,045.

KOREA

Output in December for the Oriental Consolidated.

The clean-up of the Oriental Consolidated Mining Co. for December is reported officially as follows:

Tabowie mill bullion	$ 33,903.00
Taracol mill bullion	33,557.98
Maibong mill bullion	28,597.26
Taracol cyanide plant bullion	63,593.16
Maibong tube-mill bullion	4,588.41
Total	$164,239.81

The total tonnage milled for the month of December was

KUK SAN DONG DUMP-PLANT AND ORIENTAL CONSOLIDATED MILL.

27,123 tons. No returns were received from the smelter for account of the Taracol cyanide plant.

The mills operated steadily during the month with the exception of Tabowie, which crushed 10,448 tons only, on account of hanging up 20 stamps for 17 days while the four new mortars were being installed. This work was all completed on December 20. The mines operated steadily during the month with the exception of Tabowie. On the morning of December 20 the cable of the centre compartment broke between No. 13 and 14. The cage went to the bottom with eleven Koreans who were killed. The next morning over 200 contract miners went on strike, demanding an increase in prices. They established pickets and prevented others from working. The management got between 20 and 40 men, including a few mill-hands underground, to push cars and kept the mill going. This partly accounts for the big clean-up at Tabowie, as they had to take the ore that was already broken, as the miners who were not in sympathy with the strikers were afraid to go to work. Thanks to the valuable assistance of the police the strike came to an end on the 27th and by the evening of the 28th the company had a full crew at work in their regular places at the same rates.

The large clean-up at the Taracol mill is on account of some high-grade ore from the Tongkol mine and a small bullion hang-over from the November clean-up. The Tongkol feeders averaged $12.60 per ton for 745 tons milled.

The Taracol cyanide plant has an abnormally large clean-up, the actual extraction for December being 98.4%. This is caused by the $60 per ton heads that were sent to the plant during the last ten days of November.

The hydro-electric plant closed down on December 21 for the winter. Taracol mine hoists are on steam and the company is buying ¥3000 per month of electricity from Okura & Co. to operate Taracol mine-pumps, No. 10 electric-hoist; Chintui mine, Nuchadagi valley shaft and pumping-station.

The Oriental Consolidated Mining Co. reports the clean-up for January at $152,305. The grade of ore milled was above the average of that mined for some time past.

CANADA

Mineral Production of the Dominion in 1916.

The remarkable expansion of the mining and metallurgical industries owing to the stimulus given to production by the demands of the War, is shown by the preliminary report of the 'Mineral Production of Canada for 1916' issued by the Department of Mines. The total value of the year's output was $177,357,454, as compared with $137,109,171 in 1915, an increase of 29.3%. The total value of the metallic production was $107,040,035, as compared with $75,814,841 in 1915. Gold was produced to the amount of 926,963 fine ounces valued at $19,162,025, as compared with 918,056 fine ounces of the value of $18,977,901 in 1915. The increase in the output of the Porcupine mines more than counterbalanced a falling off in the production of the Yukon Territory and British Columbia. The production of silver was 25,669,172 fine ounces valued at $16,854,635, as against 26,625,960 fine ounces valued at $13,228,-842 in 1915, a decrease of 3.6% in quantity but an increase of 27% in value. The production of copper has shown a large increase during the past three years. Last year's output amounted to 119,770,814 lb. valued at $32,580,057, as against 100,785,150 lb. of the value of $17,410,635 in 1915. The high price of the metal has stimulated production from the White Horse district of the Yukon, from which there were ore shipments of approximately 40,000 tons. Nickel was produced to the amount of 82,958,564 lb. of the value of $29,035,497, the output of the Sudbury district being supplemented by a small tonnage from the Alexo mine in Temiskaming and nickel recovered as a by-product in smelting Cobalt ores. The production showed an increase of 21%. The output of lead was 41,593,680 lb. valued at $3,540,870, a decrease of 10% in quantity but an increase of 32% in value. The zinc produced was estimated at 23,515,030 lb. of the value of $3,010,864, a small proportion of which was recovered at the new electrolytic zinc refinery at Trail. The value of the cobalt recovered as a by-product from the silver ores of the Cobalt district is estimated at $926,045. The demand for molybdenum has resulted in the development of several promising properties, which have pro-

duced molybdenite that is estimated to have a value of about $159,000.

Shipments of iron ore were 339,600 tons, valued at $814,044, as compared with 398,112 tons valued at $774,427 in 1915. The Watana mines, Newfoundland, produced 1,012,060 tons, which was shipped by the two Canadian companies operating there to their Nova Scotia plants. Pig iron was manufactured to the amount of 1,169,257 tons valued at $16,750,903, the production in 1915 being 913,775 tons of the value of $11,374,199. In addition ferro-alloys to the extent of 28,628 tons, of the value of $1,777,615 were made in electric furnaces. The production of steel ingots and castings established a new record, the total being 1,454,124 tons. The asbestos industry was particularly active with a total production of 118,246 tons, being a gain of 11%. The coal output showed an increase of 9% with a production of 14,461,678 tons valued at $38,857,557. Each of the western coal-producing provinces shows a substantial increase, while the output of Nova Scotia and the Yukon has fallen off. The quantity of coke produced was 1,448,782 tons. The production of natural gas was 25,238,568 thousand cu. ft. valued at $3,924,632, as compared with a production in 1915 of 20,124,162 thousand cu. ft. of the value of $3,706,035. The falling off in the production of structural materials and clay products which characterized the two preceding years continued in 1916. The production of portland cement was 5,359,050 bbl. valued at $6,529,861—a decrease in quantity of over 5%.

There promises to be considerable activity in the new gold district of Powell, Cairo, and adjoining townships when the snow leaves the ground this spring. About 300 claims have been staked since last fall, almost entirely on the original discovery. To facilitate recording of claims in the district, Cairo, Powell, Flavelle, Willison, Alma, Holmes, and part of the Township of Baden have been placed in the Montreal River Mining Division instead of the Temiskaming division. This will allow stakers to record at Elk Lake.

JOHANNESBURG, TRANSVAAL

A Record Production in 1916.—The Gold Output of the Rand Can Only be Sustained by New Discoveries.

As generally anticipated would be the case, the Transvaal gold output last year constituted another record, which was mainly due to the better returns obtained from the Far East Rand new mines. The total production of gold was declared by the Chamber of Mines at $9,295,538 oz. of fine gold of a value of £39,484,700, being an increase over the previous year of 207,867 oz., and in value of £857,509. The production for 1915 was a record for the Rand, but not for the Transvaal, and last year's output was a record not only for the Rand but also for the whole of the Transvaal. The previous record year for the Transvaal was in 1912, but last year exceeded 1912 by £773,389. Taking into account that the gold mines were deprived of some of their skilled labor by the War, these results were satisfactory, while the uniformity of the monthly output during the year was striking. Owing last year to a larger proportion of the tonnage milled coming from some of the best mines on the Far East Rand, the average production per ton milled was slightly better, and although the total tonnage milled during the year was again higher, the increase was not so striking as in previous years. It is evident that it will be only with difficulty that the mines on the Central and Western Rand will be able to maintain the output of last year at the same level, owing to several of the best mines becoming exhausted. The only hope for a maintained or slightly increased output lies in the Far East Rand, and it is doubtful whether, even here, the increased output during the next ten years will be able to make up for the declining output in other parts of the Rand. The Springs mine has just started the new mill, and at Daggafontein, Brakpan, New Modderfontein, and Government Areas, more stamps will probably soon come into use, but otherwise there are no prospects of any substantial improvement taking place in the Far East Rand output during the next few years. It is therefore probable that unless the opening of additional mines on the Far East Rand is accelerated, the production of gold on the Rand will in the immediate future show a decrease rather than otherwise. Nevertheless the Transvaal is in a position to maintain the present output for several years, and naturally some years must elapse before the inevitable decline sets in, which, as before remarked, can only be delayed by the opening of additional mines on the Far East Rand. Up to the end of 1916 it may be said that since the year 1884, the Transvaal goldfield has produced 121,219,666 oz. of fine gold of the value of £514,908,454, while there probably remains an equal amount still to be worked, if the undeveloped areas in the Far East Rand are taken into consideration.

Although the Transvaal production of gold showed a striking advance last year over 1915, the total dividends declared showed a decrease of £553,212. The total amount paid in dividends last year amounted to £7,271,587, as compared with £7,824,799 in 1915. No less than 22 mines out of 51 paid diminished dividends last year, but the most striking feature was the failure again of the three great producers, the Randfontein Central, Crown Mines, and the East Rand Proprietary Mines to come up to expectations. These three companies alone declared £463,624 less in dividends than during the previous year. The Randfontein Central passed its dividend on account of the pending change of control, while the disappointing results at the Crown Mines were principally due to the experiment made during the year of narrowing the stopes, so as to reduce the quantity of low-grade rock being sent to the mills. The cause of the shortage at the East Rand Proprietary Mines, however, lies much deeper, and may be traced to the unsatisfactory value of the ore disclosed at depth, and the necessity of conserving the cash assets, in face of the heavy expenditure to be incurred in search of profitable areas. In 1910 this mine distributed nearly a million sterling in dividends to the stockholders, but last year the amount paid was only £61,148.

The majority of the mines which declared higher dividends last year, were the Brakpan Mines, Modder B., Modder Deep, and the Van Ryn Deep, situated in the Far East Rand. The City Deep situated on the Central Rand increased its dividend from £421,875 to £562,500, paying in fact a larger aggregate dividend, than any other mine on the Witwatersrand. With the exception of the Sub-Nigel mine, which increased its dividend from £10,790 to £43,158, all the gold mines in the outside districts of the Transvaal paid less dividends than during the previous year. The decline in the amount of dividends is claimed to be due to the higher cost of material and stores, to the expenditure of more of the working profits in capital expenditure and improvements, and to the declining earning power of several important mines on the Central and Eastern Rand.

PHILIPPINE ISLANDS

Operations of the Benguet Con. Mines.

According to C. M. Eye, the superintendent of the Benguet Consolidated Mines, the report for the year 1916 is as follows: tons milled, 17,360; amount recovered per ton in gold and silver, $16; total bullion produced, 173 bars, weight 21,076.8 oz. troy, containing 13,269.2 oz. troy fine gold, and 4316.8 oz. fine silver. Average fineness of bullion in gold, 630; in silver, 205. Total value of bullion shipped, $277,854.73, or an average of $23,154.56 per month. All values stated are in U. S. currency, and for bullion at mint. The actual mint returns have been taken in the calculations for the first nine months of the year, and for the remaining three months for which no mint returns have been received, our own weights and assays were taken.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

NENANA. The discovery of gold in the Toklat country in sufficient quantity to warrant the belief that there is a pay-streak there is of much importance to the people of Nenana, says the Nenana *News*, and it probably will lead to the rapid development of a district that is tributary to the town and which should be supplied largely, if not entirely, by local outfitters. The Toklat is a large district, with many creeks abundantly supplied with water and timber for mining purposes, and the fact that gold has been found on one of the streams should stimulate prospecting throughout the entire region. Nenana is the natural supply point for that, as well as other nearby, districts which require provisions and mining machinery.

ARIZONA

MOJAVE COUNTY

KINGMAN. F. R. Feitshans and W. E. Campbell have been looking over the McCracken property. A new company has been incorporated to take over the mines, which will be composed of F. A. Garbutt, president; C. A. Vehmeyer, vice-president and general manager; F. R. Feitshans, second vice-president; John R. Posers, secretary and treasurer; and W. E. Campbell. A large amount of steel and camp supplies was shipped to the mines. A camp will at once be established there and mining on a large scale will be begun. Feitshans and Campbell have also taken options on tungsten claims and made locations of ground covering more than 20 claims near the McCracken. The find is only five miles from Signal and close to the highway.

(Special Correspondence.)—A streak of specimen ore two to four inches wide has been struck in the Boundary Cone mine. The discovery was made on the 450-ft. level in a vein five feet wide. The rich ore makes along a slip and is being sought in a raise from the 500-ft. level, which has cut the slip. ——The Big Jim mine reports assays from grab samples of $54 and $57 across 7 ft. in the east drift on the 600-ft. level. The east drift on the 400-ft. level is in solid ore which assays above $20. This face is within 30 ft. of the east end-line, which separates the property from the Aztec of the Tom Reed; and but 70 ft. separates the workings of the two companies on this level.——All the material and machinery for the addition to the Tom Reed mill is in Oatman, or Kingman, the railroad shipping-point for Oatman. The foundations have been completed and redwood tanks are being constructed. Marcy ball-mills will supplant stamps, the present crushing-equipment. The new mill is expected to be completed by May 1. The capacity of the mill then will be 300 tons.——The Nellie shaft is 475 ft. deep. A station will be cut at 500 ft. and a cross-cut driven through the vein. The company's engineer believes that 500 ft. will carry the workings below the leached zone and into a zone of secondary enrichment.

Oatman, March 23.

PIMA COUNTY

AJO. The Ajo Cornelia Copper Co. is making preparations to prospect its property with diamond-drills. A contract has been let to the Longyear Drilling Co., the same company that drilled the Ajo Consolidated property. The Ajo Cornelia, according to J. D. Elliott, expects to drill 1000 ft. or more in the next 60 days, and to continue drilling until 10,000 ft. has been drilled and the size of the Ajo Cornelia orebody is determined.

The Ajo Cornelia property adjoins the Ajo Consolidated on the south and east, which has blocked out with diamond-drills over 30,000,000 tons of ore. The Ajo Consolidated orebody can be traced into the Ajo Cornelia property. A two-compartment shaft is being sunk between two large fractures, showing a high-grade ore and is down to a depth of about 50 ft., but in order to prove quickly the value of the Ajo Cornelia property and the depth of the orebody, the directors, according to Mr. Elliott, have decided to diamond-drill and push the work with all possible speed.

YAVAPAI COUNTY

JEROME. The United Verde Extension Mining Co. has made an appropriation of $2,500,000 for the erection and equipment of a smelter for operation in 1918. No new financing will be necessary. From its first year as an operating property United Verde Extension finished 1916 with a surplus of $6,000,000, a large part of which was cash. Despite the fact that it was dependent upon custom smelters to handle its ores the company was able to produce its copper at an average cost of less than 6½c. per pound. The proposed smelter will have a nominal capacity of 1000 tons of ore per day. Its equipment will consist of two reverberatories and two blast-furnaces, but the management plans to have only one of each in operation at a time.

CALIFORNIA

The reports of oilfield work made to the State Mining Bureau for the week ending March 17, 1917, show 38 new wells started, making 249 new wells started since the first of the year, 15 to be inspected for test of water shut-off, 18 deepening or re-drilling, and 7 to be abandoned.

AMADOR COUNTY

(SPECIAL CORRESPONDENCE.)—The Plymouth Consolidated Mines (Ltd.) makes the following official report for the month of February:

Total tons milled	9,600
Value	$56,200
Working expenses	27,927
Development	6,633
Surplus	21,640
Other capital	399

Plymouth, March 22.

PLACER COUNTY

It is reported that a portion of the Ayers' tract, across Bear river near Van Trent, eight miles north of Lincoln, containing an extensive deposit of copper ore, has been sold to a company of Eastern men. The purchasers are planning to begin work. There is considerable activity in copper mining in the foothills east of Lincoln.

SACRAMENTO COUNTY

NATOMA. At the meeting of the Natomas Consolidated Mining Co. on March 20, all of the old officers were re-elected. The annual report of the company states that there remains 250,000,000 cu. yd. of gravel that may be dredged with profit.

On March 1, 1916, Natomas dredge No. 1 was closed down to be rebuilt at another site, and was again started up on November 20, being closed down nearly nine months. On April 1, 1916, Natomas dredge No. 7 was sunk, and was not again operated until October 1, being closed down six months.

All of the company's dredges have been maintained in first-class condition for the most effective operation.

During the year 1916 the gross gold recovery from dredging

operations (25,868,000 cu. yd.) amounted to $2,137,120, and the net operating profit was $988,885. The sum of $108,248 expended in salving and rebuilding Natomas dredge No. 7 was charged to operating expense.

The reclamation and drainage of the company's lands have been practically completed, and the larger portion of these lands was planted to crops during the past year.

The total cost to date of the reclamation work in district No. 1000 has been $2,650,000, and in district No. 1001, $1,620,000. Eighty-five per cent of the cost of the work in district No. 1000 and 43% of the cost of the work in district No. 1001 has been assessed against the lands owned by the company. The company has expended to date $130,000 on the interior development of its lands in district No. 1000, in the construction of roads, warehouses, wells, and irrigation works. About 55,000 acres of the company's lands in these two districts is under lease, and it is anticipated that 50,000 acres will be planted to crops during 1917. The completion of the reclamation work enabled the company to obtain $221,225 as rentals for its lands during the year 1916. The balance sheet as of December 1916 shows the value of gold and dredging properties to be $8,373,439.

San Bernardino County

CIMA. The Copper World mine has purchased material for a smelter to be built at Valley Wells, 20 miles north-west of Cima. Valley Wells is south of Clark mountain and is the site of the old smelter, built 20 years ago, and later abandoned. The new smelter will have a capacity of 150 tons of ore per day, and will treat the ores from the Copper World, the Emperor mine, owned by Kunze and Conway, and other properties in the Clark Mountain district. The Copper World is now shipping 280 tons per month of high-grade copper ore and the Emperor about two cars per month. The smelter will enable these and other properties to handle their lower grades of ore, which will not stand the cost of shipment. The dump remaining from the operations of the old smelter will also furnish thousands of tons of material to keep the new plant in operation.

Trinity County

CARRVILLE. The Railroad Commission has authorized the Trinity Gold Mining & Reduction Co. to sell to the California-Oregon Power Co. for $22,000 cash, its hydro-electric plant, including its transmission and distribution system, near Carrville, Trinity county. The electrical plant was built to furnish power to the Headlight mine, owned by the same interests which own and operate the power-plant.

The mine suspended in 1912, and shortly after the Trinity company contracted to supply 250 kilowatts of electricity to the Alta Bert Dredging Co., which runs a gold dredge near Trinity Center. Recently W. H. Estabrook bought the dredging company properties. The California-Oregon company has built a transmission line from Gastell, Trinity county, to Trinity Center, and wants to use the Trinity company's plant as an auxiliary power supply.

Tuolumne County

SONORA. Operations in the Hope mine, says the *Tuolumne Independent*, are confined to driving the tunnel to tap the old Tainter lead and the stoping of ore from a 3-foot vein exposed in an upraise in the tunnel 1000 ft. from the mouth. The ore extracted at this point is being put through the 5-stamp mill with profitable results. The tunnel is in 1350 ft., and it is estimated that another 200 ft. will intersect the famous old vein being sought. Nine men are employed in the mine.

Work on a three-compartment shaft on the Yosemite mine, situated near the Rawhide, has been started. The surface equipment is sufficient to sink the shaft down to a great depth. The orebodies will be tapped by cross-cutting.

The Springfield Tunnel & Development Co. has increased its capital stock to 1,000,000 shares. It is intended to raise money to continue the tunnel under Springfield flat.

COLORADO

Boulder County

BOULDER. A 3-ft. vein of silver and lead ore has been struck on the lease operated by W. G. Paulding on the White Raven property, and it is estimated that the ore will run 100 oz. per ton. Paulding has been leasing for two years, and the ore he now has contains much wire silver.

The strike was made on the 100-ft. level. Paulding will take out a carload of the ore and if conditions warrant it, he will put a large force of men to work and develop the property.

Lake County

The lessees on the Wolcott are shipping a steady tonnage of lead carbonate from an extensive shoot that is being developed in that property.

A company of local men recently organized by Harry McKeen has secured a lease on the Evelyn property situated on the east slope of Carbonate hill south from the Wolftone and south-west from the Greenback. The work of getting machinery in place and erecting a head-frame over the shaft is now under way. The Evelyn shaft is one of the best in the district and is comparatively new. It has three compartments and has a depth of 1200 ft. Aside from the shaft, little development has been done in the Evelyn property and no orebodies of importance have ever been uncovered by past operations. A small stope of high-grade silver ore was found in the mine at one time but the prospecting that followed its discovery failed to disclose other deposits. Bodies of iron are known to exist in the upper workings of the property and it is stated by those now in charge that extensive shoots of zinc carbonate will be found.

San Juan County

SILVERTON. About six months ago George B. Croft secured a lease on the St. Lawrence and other mining properties, near Red Mountain, and since that time has been running a cross-cut tunnel toward a shaft, sunk some years ago, to reach the orebody at a lower level. According to plans and measurements, it should be necessary to drive 50 ft. farther to strike the ore vertically under the outcrop. Some high-grade ore was unexpectedly encountered and a sample brought down to the Beaumont at Ouray.

Teller County

(Special Correspondence.)—The production of the mines of the Cripple Creek district for the month of February is reported by the mills and smelters as follows:

	Tons		
Golden Cycle mill, Colorado City...	32,000	$17.00	$544,000.00
Portland mill, Colorado Springs....	10,536	19.82	208,823.52
Smelters at Denver and Pueblo.....	2,000	55.00	110,000.00
Portland Gold Min. Co., Victor mill.	18,750	2.27	42,562.50
Isabella Mines Co., Victor mill.....	1,430	2.80	4,004.00
Worcester-Rubie mill, C. C. district.	250	3.90	975.00
	64,966	$14.01	$910,365.02

During February the Roosevelt tunnel was advanced 150 ft. For the last 50 ft. the heading has passed through hard mineralized phonolite. Low assays are reported from the dike. The consulting engineer for the tunnel company has been instructed to change the course of the tunnel to head for the shaft of the Portland Gold Mining Co. on Battle mountain.

Al. Osberg and associates of Cripple Creek have secured a three year lease on the Mable M. shaft and main workings of the Gold Dollar Con. Mining Co. on the eastern slope of Beacon hill.

Work on the new vertical (Frankenberg) shaft of the Modoc Consolidated Mines Co. is progressing rapidly. With the 500-ft. of the old shaft connected by raises, the new shaft is being timbered down to the ninth level. The raise from the 11th level of the old incline shaft is nearly completed. It is ex-

pected that the new shaft will have been completed down to the 1500-ft. level, and the new electric plant installed and in operation by July 1, 1917.

Messrs. Cornduff & Duncan, successful lessees on the Dead Pine property of the Granite Gold Mining Co. at Victor, have secured a two-year lease on mines of the Commonwealth Mining & Milling Co. This property is situated in Arequa gulch and on the north-east slope of Beacon hill.

The Copeland sampler has been thoroughly overhauled and is now occupied by the Eagle Ore Co. Additional equipment has been added by the Eagle Ore Co., so that they are prepared to handle promptly all shipments to the new sampler.

The annual meeting of the stockholders of the El Paso Con. Gold Mining Co. will be held at the office of the company in the Exchange National Bank building, in Colorado Springs, on Monday, April 9.

Victor, March 17.

MICHIGAN

Houghton County

Houghton. At a recent meeting of the Tamarack Mining Co. the shareholders voted to sell the assets of the company to Calumet & Hecla for $3,600,000, or $60 per share; 48,061 shares were voted in favor of the sale—more than the three-fifths required. There was no opposition. Thus, after many years of negotiation, the Tamarack mine has at last passed to the ownership of the Calumet & Hecla company. This company had paid, up to July 1, 1916, a total of $132,250,000 in dividends, equivalent to $1322.50 per share.

Production at the Mass Consolidated mine will be pushed as fast as men can be secured. About 450 men are now employed and 100 more could be used. The stamp-mill is handling production easily and not working to capacity. Three boilers at 'C' shaft are being replaced by three larger ones that will add one-third to the capacity. The old boilers will be moved to the mill at Keweenaw bay, where they will be used as a reserve unit. It is planned to sink 'C' shaft about 400 ft. and carry on development below the 1300-ft. level as rapidly as men can be spared for the work. These operations are expected to add 1,000,000 tons of rock to the present reserve, estimated to be enough for three to five years.

MONTANA

Silverbow County

Manager John Gillie of the Anaconda Copper Mining Co. says that the fire situation at the Leonard, West Colusa, and Tramway mines is considerably improved. Work has been resumed with nearly normal crews at the West Colusa and Leonard and progress in fighting the flames and gas at the Tramway is being made. Owing to the fact that considerable water was thrown into the Tramway, which caused the bulkheads to settle and crack, permitting gas to escape from the imprisoned areas, headway is slow, but it is believed that the situation has been brought under control. Several days will be required to complete the work of bulkheading, but confidence is expressed that the fire and gas eventually will be confined in so small an area that work can be resumed under practically normal conditions.

NEVADA

The output of metals for Nevada during 1916, according to the United States Geological Survey was as follows:

Gold	$ 9,000,000	22% decrease from 1915
Silver	9,000,000	23% increase over 1915
Copper	28,120,000	134% increase over 1915
Lead	1,596,000	104% increase over 1915
Zinc	4,759,000	57% increase over 1915

Despite a decrease in gold output of over $2,000,000 from 1915, Nevada continues to hold the fourth place as a gold producer, as in 1915, California, Colorado, and Alaska each having a larger output.

There was a decrease of nearly a million ounces of silver, but owing to the higher price of silver there was an increase in value of output amounting to nearly two million dollars. In silver production, Montana was first, Utah second, and Nevada third. While the production of the Tonopah district decreased, that of the Rochester district increased in both gold and silver. In the Comstock district there was an increase of approximately 60% in the value of the gold and silver output.

(Special Correspondence.)—The Legislature has enacted a measure providing that the Industrial Insurance Commission may take charge of any case in which it is shown that companies are not giving employees proper medical and hospital care, charging all expenses to the employer. The bill was fought by the mining companies on the ground that it admitted many abuses and reflected on employers.

A bill has been passed creating a State Bureau of Mines, and is certain of the approval of Governor Boyle. It will be operated along the lines of the Californian institution, plans already being made for much field work.

By a close vote the Senate defeated a bill to tax the gross output of mines. Opponents of the bill stated it would prove a prohibitive measure for the mining industry if adopted, and that the mines were already bearing a heavy burden.

The Legislature authorized the establishment of two new schools of mines, one at Goldfield, the other at Ely. Each community is expected to contribute to the support of the institutions, which will be modeled along the lines of the schools at Tonopah and Reno.

Nevadan mining will benefit largely from the new Highway measure, which provides for several excellent roads. The main highways will extend from a point east of Elko to the Californian line, by way of Reno, and from Elko to connect with the roads to Los Angeles, passing through Ely, Tonopah, and Goldfield. There will be several connecting roads.

Carson City, March 19.

Nye County

(Special Correspondence.)—Plans for the extensive development of the old Tybo mine to the 800-ft. level are being carried out by the Louisiana Consolidated Mining Co., which has recently acquired that property, 110 miles north-east of Tonopah. The mine is credited with an output of $5,000,000 from 1872 to 1880 and was worked down to the 400-ft. level. A good force is employed and the property is being equipped with a Diesel-engine power-plant, with electric generators, compressor, new hoist, and two sets of electric pumps. Later on power will be secured by the 30-mile extension of the Nevada-California Power Co.'s transmission-line from Belmont, after which the plant will be held in reserve as an auxiliary. A number of prominent Eastern capitalists have become interested with Walter E. Trent in the Louisiana company and they have decided to build a 500-ton smelter at Tybo, as well as a railroad that will connect either with Ely or Eureka on the north and Tonopah on the south. The bill granting the franchise for this railroad was passed by the Legislature and signed by Governor Boyle on March 20.

Tybo, March 22.

Storey County

(Special Correspondence.)—The Overland, Democrat, Lager Beer, Succor, and School mines at Silver City have been acquired and merged by a New York syndicate represented by Oscar Daube. It is stated work will start at once with Walter Techow, superintendent of the Andes mine at Virginia City, in charge.

Preparations are being made for extensive operation at the Phoenix-Comstock group, that recently passed to Jesse Knight and associates of Salt Lake. Sinking will start as soon as the new equipment is in place.

The Mexican company is preparing for vigorous work on the 2900-ft. level. On the 2600-ft. level of the Union Con., a rich streak is being mined from the east winze, and shipments are going to the Mexican mill. Old drifts are being re-opened on

the 2000 and 2300-ft. levels and a vigorous campaign of prospecting has been arranged.

Virginia City, March 20.

NEW MEXICO

Grant County

(Special Correspondence.)—Negotiations are in progress for the purchase of the Royal John mine, 18 miles east of Santa Rita, in the Black Range. The prospective purchasers are represented by D. C. Jackling. This probably means another big Guggenheim property in New Mexico. Engineers are unanimous in the opinion that the Royal John and adjoining properties should make one of the great lead-zinc mines of America. ——The Republic mine at Hanover is developing a splendid orebody of high-grade zinc-blende on the 100 and 150-ft. levels. This mine is still a prospect, but a good one.——The United States Copper Co., at Hanover, has resumed operation, after having purchased the Hardscrabble group of claims at Pinos Altos; also the Davidson saw-mill near Pinos Altos. The work done thus far has been of a preliminary character, no ore having been broken.——The Hanover Copper Co. is said to have a great deal of calamine in sight. This is the property successfully leased by Becker, Hanraty, and Thomas last summer.

George Bethune is examining the Davidson property one-half mile north of Fierro. This mine has produced within the past year over 100 cars of copper ore, 65 cars of which ran above 7%.——The Colorado Fuel & Iron Co. is installing a compressor at the Cupulo iron mine at Hanover.

Hanover, March 20.

Socorro County

(Special Correspondence.)—On March 1 The Oaks Co. paid its fourth consecutive monthly dividend of 1% on outstanding preferred stock.

The shaft on Johnson mine is now down 400 ft., with stations and levels at each 100-ft. point. Ore has been exposed for the entire depth. A small compressor will be installed at once, all drilling thus far having been done by hand. A gasoline hoist is used. The property is owned by Socorro Mining & Milling Company.

The North drift from the 50-ft. level in the Eberle mine continues in ore and a shipment to custom mill will be made soon.

A cross-cut is being driven from the adit level on the Clifton mine to determine the location of the foot-wall. This is part of the Queen Vein system of the district and the vein is of mammoth proportions for a greater part of its extent.

The Mogollon Mines Co. is working steadily on the tailing flume down Silver creek. The better weather will expedite the installation and the terminus, at impounding dams on Mineral creek, about three miles below, should be reached this spring.

At the Maud S. mine The Oaks Co. is cleaning out old drifts and getting ready for extensive development. The property was recently taken under bond and lease. It has produced around one million dollars and a great extent of virgin ground remains to be explored, in which there is reason to believe will be found ore as good as that which afforded the mine's past production.

Mogollon, March 20.

OKLAHOMA

Tulsa County

Tulsa. On March 17 one of the biggest deals in mining leases ever consummated in the district was closed when J. R. Cole and associates of Tulsa paid $300,000 for the transfer of first leases on 240 acres near Tar river, held by Temple Chapman, Greenville Chapman, O. Longacre, and Dan Sullivan.

Mr. Cole and his associates have been interested in second leases on the land upon which they now have obtained the first leases. They also have other interests in the Miami field, having only last week paid $55,000 for the Red Eagle mine near Century. On the 240-acre lease sold yesterday, ten lessees are operating and rich mines have been developed. Five large concentrating plants already are in operation and three more are being considered. The mills in operation are the Bethel, Croesus, Tar Creek, Lucky Bill, and Lucky Junction.

The Chapmans, Longacre, and Sullivan took over the lease three years ago. They put down about 100 drill-holes and proved up ore deposits thoroughly.

Two hundred acres of the property is leased out from the land-owners at 8% and the sub-lessees are paying 15%. On the forty-acre tract the first lease is for 15% and the sub-lessees pay 20%. This tract is known as the Cornfield lease and on it are situated the Lucky Bill and Lucky Junction mines.

OREGON

Josephine County

The W. & O. Mining Co. of Seattle, has applied to the California State Water Commission in two separate applications for permission to appropriate the waters of the west fork of the east fork of the Illinois river, in Del Norte county, tributary to the Rogue river in Oregon. It is proposed to carry the water back again into Oregon where it is to be used for hydraulic mining on the Osgood claims, near Waldo, the proposed ditches and flumes being 9½ miles long. A total of 230 cu. ft. per second is asked in the two applications. It is proposed to construct two dams across the stream and these with the other works have an estimated cost of $30,000.

VIRGINIA

The Copper Corporation has been organized to exploit copper deposits at Shawville. E. D. Miller is president, and S. C. Snead, is secretary and treasurer.

WASHINGTON

Ferry County

(Special Correspondence.)—The following shipments of ore from Republic are reported for the week ended March 15: From the Knob Hill mine, 210 tons, and by the Northport Smelting & Refining Co., 290 tons.

The Lone Pine-Surprise Consolidated Mining Co. contractors have finished sinking the shaft and sump on the Last Chance mine to a depth 530 ft. and cut the vein, 7 ft. wide—all in ore that averages $16 per ton. The company is now cutting out a station on the 500-ft. level and when this is completed will break ore for shipment to the smelters.

It is reported that the Ben Hur, San Poil, North San Poil, and Trade Dollar mines have been taken under option by an Ohio syndicate.

The Tom Thumb Mining Co., having the Tom Thumb and Rebates mines under lease and bond, reports a great improvement in the Tom Thumb mine, where a shoot of ore has been found richer than any ever before encountered in that property. The company is breaking ore which it will ship on March 15 and hopes to maintain shipments of 150 tons weekly. The working force on this property will be increased.

Republic, March 14.

WYOMING

Natrona County

Casper. Plans have been perfected for an amalgamation of all interests in the Pilot Butte oil-field with the Hall Oil Co., the largest producer at present, as the nucleus of the combination. The Hall company has a daily production of 2000 barrels of oil from seven wells, all of which are shallow. Interests identified with the Midwest Refining Co., the Imperial Oil Co. of Canada, and the Burlington Railroad Co., are involved in the new plan. Under the new arrangement a deep well is being drilled, and in the event that this well proves the existence of oil at depth, the deep drilling of the entire Pilot Butte district will be pushed with vigor. The new interests have guaranteed to build a three-inch pipe-line from

the field to Riverton, on the Chicago & Northwestern railroad, if the lower strata of the sand do not yield oil in commercial quantities, while if a pool is discovered at depth, a six-inch pipe-line will be laid to Bonneville, on the Big Horn division of the Burlington railroad, whence the crude oil may be shipped to either Casper or Greybull for refining.

The new owners have an option on 1,100,000 shares of the stock of the Hall Oil Co., now held by the original underwriters, and have taken options on other properties in the same district.

(Special Correspondence.)—Ore is being shipped from the Del Paso mine in Copper Mountain district, to the smelters at Omaha. The ore averages 17% copper.

Casper, March 10.

PLATTE COUNTY

Within a few weeks, Edward Manion of Lead will commence the execution of a contract with the Great Western Sugar Co. for the delivery of 180,000 tons of limestone yearly, for a period of two years, says the Lead *Call*. The details of the agreement have been decided upon and the contract signed. The rock is to be taken from a quarry near Guernsey, Wyoming, and has been found to be of a quality peculiarly suited to the requirements of the sugar company, in connection with their manufacturing process.

CANADA

BRITISH COLUMBIA

The Hedley Gold Mining Co. (Nickel Plate mine) has declared a dividend of 3%, and an extra dividend of 2%, payable March 31, to stockholders of record at 12 o'clock noon, March 24.

SANDON. The orebody struck recently in the Silversmith vein of the Slocan Star Mines, Ltd., has been followed by drift for 100 ft. on the tenth level, says Oscar White, superintendent. It has a width of 14 ft. In addition to ore of a good milling grade it contains much silver-lead ore of a high grade. Operation of the mill has been proceeding steadily since Sunday of last week. In the first three days a carload of lead concentrate was produced.

Enough water to generate electric light for the town of Sandon has been supplied by laying 1400 ft. of wooden pipeline between the dams of the two corporations. The pipe-line delivers the overflow in an eight-inch stream. The arrangement permits operation of the Slocan mill on a basis of a shift a day, at which rate milling will be continued until the water supply is increased, which is expected to be soon.

KOREA

(Special Correspondence.)—The Seoul Mining Co., operating the Suan Concession in Whanghai province, Chosen, reports the following results for the month of January, 1917: Total recovery, $119,955. Both mills lost five days because of stolen power-line. The Tul Mi Chung mine continues to improve. New orebodies found in No. 1 tunnel assay well above the average and the possibilities are excellent. Several prospects continue to develop ore.

Seoul, February 15.

MEXICO

Owners of idle American mining properties in Mexico may yet obtain exemption from General Carranza's recent confiscation decree if they file immediately with the Carranza government their reasons for not resuming operations and make application for extension of their concessions. Ambassador Fletcher has notified the State Department that he had been assured such applications would be granted if accompanied by the proper data regarding the property in question and by a statement of how soon mining work, interrupted by the revolution, can be resumed. The ambassador said, however, that it was imperative for applications to be filed immediately if confiscation is to be avoided.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

H. C. HOOVER has returned to Europe by way of Spain.

W. J. ELMENDORF has returned from Denver to Seattle.

W. ROWLAND COX has returned to Mogollon, New Mexico.

JOHN C. RALSTON, of Spokane, has been in San Francisco.

WILLIAM W. MEIN is here on a short visit, from New York.

SCOTT TURNER is in Bolivia, but expects to return home soon.

ELLSWORTH DAGGETT, of Salt Lake City, is in San Francisco.

STEWART RAWLINGS has returned from the San Luis mine. Durango, Mexico, and is now at New York.

GARDNER WILLIAMS, who has been in San Francisco, for several months, is returning to Washington, D. C.

GEORGE B. BUTTERWORTH has returned from New York to Aroa, in Venezuela, where he is manager for the South American Copper Syndicate.

VICTOR C. ALDERSON has taken JOHN M. BAKER and HAMILTON W. BAKER into partnership with him, the firm to be known as Alderson, Baker, and Baker.

JAY LONERGAN has resigned as professor of mining in the Peking Government University and expects to return to America and resume active practice.

CHARLES E. BUNKER, at one time superintendent of the Keystone mine, has been appointed superintendent of the Bunker Hill mine near Amador City, California.

J. W. WHITEHURST has resigned as general manager of the Candelaria mines, at San Dimas, in Durango, Mexico, in order to recuperate. He is now at Salida, Colorado.

EDGAR A. COLLINS sails on April 12 by the 'Tenyo Maru' for Yokohama and Vladivostok, on the way to the Altai, where he will be manager of the Ridder mine, of the Irtysh Corporation.

E. K. SOPER and R. R. GOODRICH, professors of mining and metallurgy at the University of Idaho, have been appointed consulting metallurgists for the United States Bureau of Mines.

JOHN H. BANKS, of the late firm of Ricketts & Banks, announces that his son, HAROLD P. BANKS, has been taken into partnership. The address of the new firm of John H. Banks & Son will remain at 61 Broadway, New York.

Obituary

LEBBEUS H. MITCHELL died at the National Soldiers Home, near Los Angeles, California, December 11, 1916, aged 83 years. He was a graduate of Union College, Harvard University, 1865; and later took a course in mining, metallurgy, and geology at Freiberg, 1866-'67. He was appointed Professor of Mining, Engineering, and Metallurgy at Cornell University in February 1868, and resigned in the autumn of the same year to take up journalism in New York. He was editor and manager of industrial journals in New York from 1868 to the autumn of 1873. He served two years in the Civil War as topographical engineer on the staffs of Generals Hooker and Mead. He went to Egypt in September 1874, and until November 1881 served the Egyptian government as geologist, mineralogist, and engineer. Again, from March 1886 to July 1888, he explored the petroleum regions of the Red Sea and conducted drilling operations for the Egyptian government. Under the Garfield-Arthur administration, November 1881 to May 1885, he was connected with the office of U. S. Consulate at London, and for six months was Acting Diplomatic Agent and Consul-General for the United States at Cairo. In the late nineties, he spent two and one-half years in Central America as geologist and mineralogist for an English mining syndicate, where he did scientific work of a high character. Aside from the foregoing, he did much other professional work in this country and abroad.

THE METAL MARKET

METAL PRICES

San Francisco, March 27.

Antimony, cents per pound	24
Electrolytic copper, cents per pound	38
Pig lead, cents per pound	9.50—10.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$115—120
Spelter, cents per pound	13
Tin, cents per pound	50
Zinc-dust, cents per pound	18—20

ORE PRICES

San Francisco, March 27.

Antimony, 50% metal, per unit	$2.00
Chrome, 40% and over, f.o.b. cars California, per ton	18.00—20.00
Magnesite, crude, per ton	8.00—10.00
Tungsten, 60% WO_3, per unit	17.00—17.50
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 50% (under 35% metal not desired)	29.00

Manganese ore, 40 to 45%, sells f.o.b. Chicago at 58c. per unit with a penalty of 50c. per unit for more than 8% silica.

EASTERN METAL MARKET

(By wire from New York)

March 27.—Copper is dull and lower. Lead is steady at 9.50c. Zinc is quiet at 10.67 to 10.75 cents.

Antimony: Antimony continues in good demand for spot deliveries and prices are now 32 to 33c. for spot, with forward quotations, according to position, ranging from 13½ down to 14½c. Needle antimony has again been sold for shipment at 9¼c. and spot delivery at 12c. Antimony ore remains exceedingly scarce with practically an impossibility to get freight from South America. The nominal quotation is $2.30 per unit for shipment with $2.60 for spot delivery asked and maintained.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
Mch. 21	35.75	Feb. 13	33.90
" 22	35.75	" 20	35.37
" 23	35.75	" 27	36.00
" 24	35.50	Mch. 6	36.29
" 25 Sunday		" 13	36.25
" 26	35.50	" 20	35.87
" 27	35.50	" 27	35.62

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

The Calumet & Hecla Mining Co. reports the copper production, in pounds, during the month of February and thus far for the year, by the mines controlled by the company, as follows:

	For February	For the year
Ahmeek	2,261,356	4,672,685
Allouez	742,250	1,603,663
Calumet & Hecla	6,230,533	12,807,401
Centennial	151,759	315,600
Isle Royale	1,141,888	2,314,037
La Salle	173,511	304,272
Osceola	1,495,058	3,009,000
Superior	185,888	504,686
Tamarack	529,315	1,114,643
White Pine	250,449	619,146

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
Mch. 21	9.50	Feb. 13	8.60
" 22	9.50	" 20	9.58
" 23	9.50	" 27	9.45
" 24	9.50	Mch. 6	11.54
" 25 Sunday		" 13	9.50
" 26	9.50	" 20	9.75
" 27	9.50	" 27	9.50

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
Mch. 21	72.25	Feb. 13	77.62
" 22	72.25	" 20	78.41
" 23	72.12	" 27	77.37
" 24	72.12	Mch. 6	76.50
" 25 Sunday		" 13	75.06
" 26	71.87	" 20	72.91
" 27	71.75	" 27	72.06

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

The stock of silver in Bombay on March 1 consisted of 2400 bars. The stock in Shanghai on February 24 consisted of about 27,800,000 oz. in sycee and $17,100,000, as compared with about 25,000,000 oz. in sycee and $17,100,000 on February 17.

Statistics for the month of February are appended:

Highest price, 38 7/16d.; lowest, 37 5/16d.; and average, 37.742d.

The 'Metal Bulletin,' under date of February 27, 1917, states that "according to the estimate issued by John McLeish, of the Department of Mines, the production of silver for Canada during the calendar year 1916 was 26,000,000 fine ounces."

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date		Average week ending	
Mch. 21	10.67	Feb. 13	10.52
" 22	10.75	" 20	10.54
" 23	10.75	" 27	10.70
" 24	10.75	Mch. 6	10.85
" 25 Sunday		" 13	10.87
" 26	10.75	" 20	10.69
" 27	10.75	" 27	10.74

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date			
Feb. 27	135.00	Mch. 13	105.00
Mch. 6	115.00	" 20	115.00
		" 27	120.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

The directors of the New Idria Quicksilver Mining Co. have declared a quarterly dividend of $1, payable March 31 to stock of record March 24.

The five previous dividends were $1 each.

This dividend was more than earned in the first two months of 1917 alone. The price of quicksilver has been advanced from $105 to $120 per flask.

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	....	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

ORES

Tungsten: More domestic than foreign buying features the market and considerable quantities of concentrate have changed hands at $17 per unit. There are numerous foreign inquiries. The alloy, ferro-tungsten, has sold at $2 and lower per lb. of contained tungstic acid. Arrivals of the ore the past week have not been large.

Molybdenum: Some of the orders for ore are not to be completed because of late deliveries, and this has eased the market. About $1.80 per lb. MoS_2, instead of $2 last week, has been offered for the best grade of ore.

Eastern Metal Market

New York, March 21.

All the metals are dull except tin, some of them being lower and some nominal. Copper is dead with little business being transacted. Zinc is still stagnant though a little lower, the volume of transactions being small. Lead continues to assume an easier tone so that spot demand has been nearly eliminated. Tin is strong and higher because of an advancing market in London. Spot antimony is scarcer and higher, being nominal at 32 to 33 cents.

In the steel market prices continue to advance. International affairs have been a large factor in this because foreign demand shows no let-up and this has stimulated domestic covering. Pig-iron continues to go up, the increase this last week having been from $1 to $2.50 per ton. Sales have even been made for first half of 1918. The statement of the Steel Corporation for 1916, issued today, shows the remarkable surplus of over $201,000,000, against $44,000,000 for 1915.

COPPER

The most interesting feature of the week in an otherwise featureless market was the announcement yesterday that the leading copper producers had sold over 45,000,000 lb. of copper to the United States government at 16.6739c. per lb., which is from 20 to 14c. below the present prices for the specified deliveries. The metal is to be delivered in approximately equal quantities each quarter from April, 1917, to April, 1918, the Navy taking 20,000,000 lb. and the Army 25,510,000 lb. The delivery is to be in regular shapes at Atlantic seaboard points. In a public statement the sellers say:

"We offer the copper at this price notwithstanding our costs for labor, materials and supplies, etc., vary from 30 to 75% above the average during the 10-year period because we believe it to be our duty to furnish the requirements of the Government in preparing the nation for war with no profit more than we receive from our regular production in normal times."

The strike at the Laurel Hill refinery of the Nichols Copper Company is still effective and is interfering with production and deliveries. This week smaller strikes elsewhere are delaying both February and even March shipments so that it is not unlikely that some consumers and buyers may have to go directly into the market. The entire market is slow and lacks snap and life. A little business has been done each day but the volume has been small. A week ago today a slight softness developed but the tendency now is stronger. Prospects of war are likely to further strengthen the market. The quotation yesterday was 35.75 to 36c., New York, for electrolytic for early delivery with second quarter metal at 34 to 35c., third quarter at 31 to 32c., and fourth quarter at 30 to 31c. The London market is unchanged at £151 for spot electrolytic. Information as to exports is withheld from the public until further notice, by order of the Government.

LEAD

The feature of the market is the continued large arrivals of lead which have been held up in transit from the West and which began to come more freely a week ago. These receipts have been so general that they have practically stopped the demand for spot metal which last week was as high as 10c. and is now as low as 9.50c., New York. Generally all buyers have shared in these large arrivals, some to such an extent that they have more than they need and have offered some for sale. These conditions have caused the market to ease off and have dispelled the anxiety that was prevalent less than two weeks ago. The threatened railroad strike caused some uneasiness, but its elimination will relieve still more freight congestion and it is predicted that prices will be lower rather than higher. The quotation for prompt March shipment is 9.50c., with April at 9.25c. and May at 9c. The London spot-price is £30 10s., unchanged from a week ago. It is stated that producers in general are not at all alarmed for the reason that the spot-price has softened because production, since January 1, 1917, has not been up to the mark, so that futures are likely to hold strong.

TIN

The outstanding fact as well as the surprise of the market has been the sharp advance in tin in London the past week. Spot Straits tin, which a week ago yesterday was quoted at £201, is now £214 2s. 6d. and spot standard metal is now £214 against £201 15s. last week. Even future standard tin has advanced decidedly, being quoted yesterday at £213 against £200 5s. a week ago. The causes for these sensational increases are practically all guess work on this side. Prominent importers here seem to be strangely uninformed by their London connections. The explanations that are being offered is that possibly an income tax on exports of tin from the Straits has been put in force or is about to be, or that a vessel carrying a large cargo of tin has been sunk, which information the British authorities may be keeping from the public. The effect on this market has been to make it much stronger, whereas a week ago it was dull. Sales have not been large in the past week, perhaps 400 to 500 tons in all. After a dull day, last Wednesday, the market became more active on Thursday when spot-metal sold from 52.87½ to 53.50c., most of it going at the latter price. Monday and Tuesday of this week the market became much stronger, about 100 tons changing hands on Monday, the price yesterday advancing to 56c. for spot metal, against 53.50c. a week ago. The tin arrivals are reported as 1585 tons with 3791 tons afloat. Imports of tin at Pacific ports in January, 1917, were 1,471,729 lb. at San Francisco and 3,350,161 lb. at Seattle, with a total valuation of $1,804,256.

ZINC

The market is weaker than it was a week ago, due to the activities of some of the weaker interests that do business anyhow on some scale. Very little buying has been reported and the market as a whole is dead. Definite bidding appeared yesterday at 10.50c., St. Louis, for spot spelter, and this may be regarded as the spot or nearby quotation which is 10.67c., New York, and nominal. As long as the ore-market is high and the spelter-market weak, the tendency will be dull. Galvanizers are doing nothing and there is practically no demand now from the brass interests. The April quotation is about 10 to 10.12½c., with second quarter at 9.50 to 9.75c., both St. Louis. The market cannot be regarded as weak, but as easier and dull. Zinc ore is reported as a little lower but not enough to have any effect.

ANTIMONY

Because of the continued holding up of shipments of Chinese and Japanese metal on the way from the Pacific Coast, the spot-market is higher. The quotation is at least 32c., nominal, and it is said offers of 33c. have brought out no antimony. Large lots are unobtainable. Metal for delivery in New York in March has been sold at 29c. for small lots. Futures attract little attention, shipments from the Orient being quoted at about 15c. for March and 14.25c. for April. Needle antimony has sold for shipment at 9.25c. and for spot delivery at 12 cents.

ALUMINUM

The market is unchanged from last week and the nominal quotation remains at 58 to 60c. per lb. for No. 1 virgin aluminum, 98 to 99% pure.

Mining and Scientific Press

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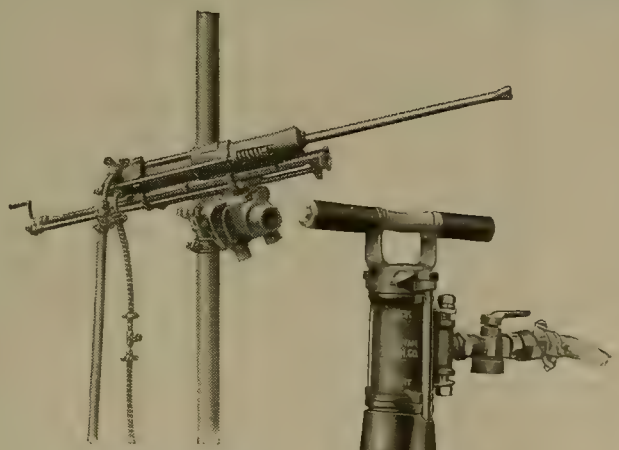

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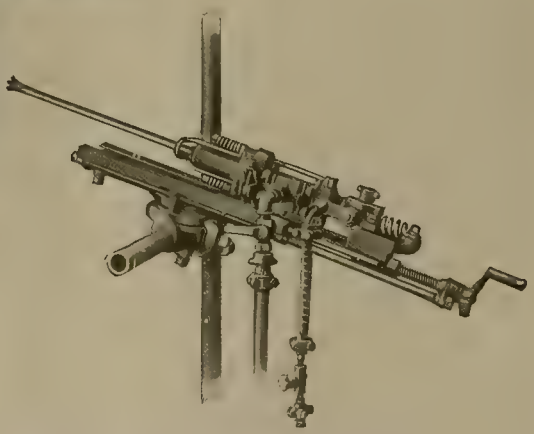

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In This Issue:

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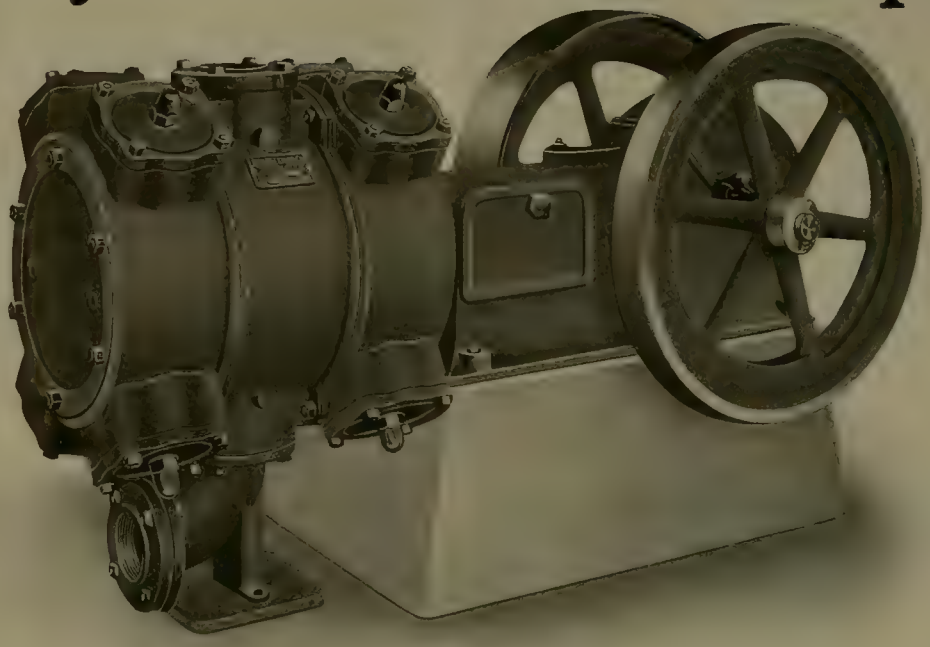
Sulphur Di-Oxide as a Floatative Agent

Dry-Vacuum Pumps



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UNION CONSTRUCTION COMPANY

The Union Construction Page

UNION CONSTRUCTION COMPANY

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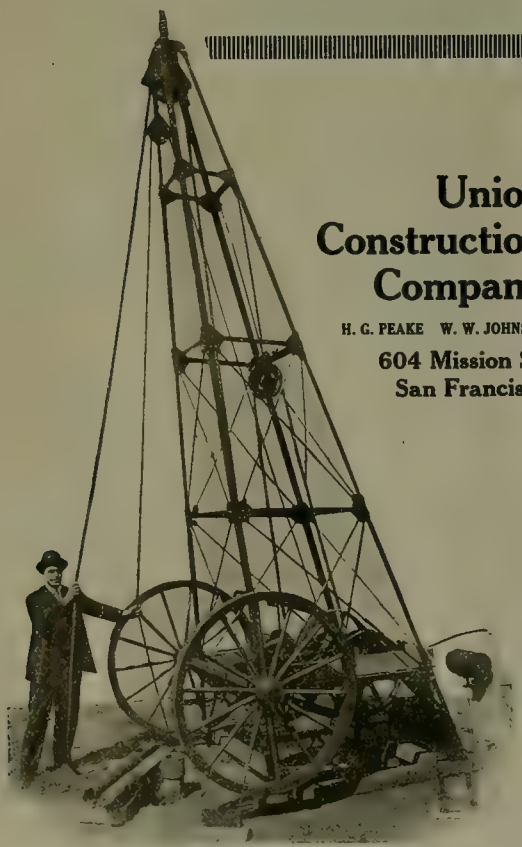

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EDITORIAL

T. A. RICKARD, Editor

AT the moment of going to press the message of the President is published. We deem it sufficient at this time to quote a small part of the message, as expressing the high purpose of our people. "Our object is to vindicate the principles of peace and justice in the life of the world as against selfish and autocratic power, and to set up amongst the really free and self-governed peoples of the world such a concert of purpose and of action as will henceforth insure the observance of those principles. Neutrality is no longer feasible or desirable where the peace of the world is involved and the freedom of its peoples, and the menace to that peace and freedom lies in the existence of autocratic governments backed by organized force, which is controlled wholly by their will, not by the will of their people. We have seen the last of neutrality in such circumstances. We are at the beginning of an age in which it will be insisted that the same standards of conduct and of responsibility for wrong done shall be observed among nations and their governments that are observed among the individual citizens of civilized states. We have no quarrel with the German people. We have no feeling towards them but one of sympathy and friendship. It was not upon their impulse that their Government acted in entering this war. It was not with their previous knowledge or approval. It was a war determined upon as wars used to be determined on in the old unhappy days when people were nowhere consulted by their rulers and wars were provoked and waged in the interest of dynasties or of little groups of ambitious men who were accustomed to use their fellow men as pawns and tools. . . . Just because we fight without rancor and without selfish objects, seeking nothing for ourselves but what we shall wish to share as free peoples, we shall, I feel confident, conduct our operations as belligerents without passion and ourselves observe with proud punctilio the principles of right and of fair play we profess to be fighting for. . . . It will be all the easier for us to conduct ourselves as belligerents in a high spirit of right and fairness because we act without animus, not in enmity toward a people or with the desire to bring any injury or disadvantage upon them, but only in armed opposition to an irresponsible Government which has thrown aside all considerations of humanity and of right, and is running amuck."

RUMOR was current recently that the Roessler & Hasslacher Chemical Company had filed incorporation papers with the Secretary of State in California looking toward the manufacture of cyanide on the West Coast. The filing of these papers, however, did not indicate an early realization of this purpose. We are able to state that the new works, necessitated by the withdrawal of power-privileges at Niagara Falls by action of the Dominion of Canada, are in process of construction at Perth Amboy, New Jersey. The primary condition determining the selection of a site was that of rapidity in assembling the equipment, which could be accomplished only in the East. The new plant will be in operation by the end of June.

ENGINEERS and other professional men desiring to serve their country are advised to write to the Secretary of the Institute or to the Adjutant General, U. S. Army, Washington, D. C., for particulars of the service they can render. In our issue of November 18, 1916, we published an article on the organization of an Officers' Reserve Corps. This article, by Mr. A. H. Babcock, gave a great deal of timely information.

ANOTHER engineering society has been organized. The Southwestern Society of Engineers came into being early in March at El Paso. Membership is open to practitioners in all branches of engineering. It is planned to hold at least two conventions every year and to stimulate comradeship among engineers in the Southwest. The meeting on March 8, 9, and 10 was marked by the reading of several interesting papers, including one by Mr. Gerald Sherman, of Bisbee.

HIGH prices for copper are not wholly translatable into large or excessive earnings, as appears from the experience of the Calumet & Hecla. In conformity with the usual practice it has been selling export copper on the basis of commissions, insurance, and freight paid to destination. With ocean-freight 700% above normal, and marine insurance at 10% on the value of the cargo, the cost of delivering copper to foreign buyers is not less than 7 cents per pound. Such extraordinary conditions add to the burdens and uncertainties of custom-smelters in even higher degree.

TIN shipments from Bolivia to the United States are changing the market-conditions for that metal. Normal importations of tin from all sources average about 52,000 tons per annum. In March 1915, the American Smelting & Refining Company undertook the reduction of Bolivian tin concentrate at Perth Amboy, New Jersey, smelting in a reverberatory furnace, and refining electrolytically. The capacity of the plant was 600 tons per month, which has proved to be inadequate. Additional equipment will bring up the monthly production to 1500 tons by July 1. Transference of tin-smelting on such a scale from Europe to this country

will undoubtedly encourage the further development of the sporadic tin deposits in South Carolina, South Dakota, Texas, and other American localities.

RETIREMENT from active life of so prominent a figure as Dr. James Douglas seems like the passing of an epoch. His influence has been part of the up-building of the West, not only in the work of material development but in metallurgical pioneering at the same time. He has been a creator of industry in the best of ways, overcoming the obstacles of the desert, solving difficult problems in practical operation, and establishing new trunk-lines of communication. He now becomes chairman of the board of Phelps, Dodge & Company, relinquishing the presidency to his son, Mr. Walter Douglas, and also turning over the presidency of the El Paso & South Western Railroad to other hands. Dr. Douglas is the recognized dean of American mining engineers, to whom individually and collectively he has always been a friend and an inspiration.

DISCUSSION this week includes a letter from Dr. Otto Sussman, a mining engineer of high standing, who takes exception to an item of news appearing in one of our recent issues and sent to us by our correspondent at El Paso. We are glad to publish the correction. Mr. W. R. Cramer, an experienced metallurgist, contributes an interesting note on the use of caustic soda in flotation. The use of this chemical as a deflocculant in the old Dominion mill is suggestive. Mr. Edward Thornton writes, from Arizona also, to describe his method of sampling a large low-grade orebody, valuable for its copper content. The notes he furnishes will be appreciated by other mining engineers, particularly the drill-holes traversing the ore to be sampled in V-shaped series. Mr. E. H. Wedekind expresses himself concerning the Hall sulphur process and thereby furnishes a useful warning. We hope that further information concerning trials of this process now being made at Mount Lyell, in Tasmania, may be forthcoming.

OUR correspondent at Johannesburg, reviewing last year's results of mining on the Rand, refers to an attempted improvement of the grade of the ore hoisted from the Crown Mines by decreasing the width of stoping. This proved disappointing. Evidently the pendulum of change has swung pretty violently since the days when the managements on the Rand chased the lure of low cost per ton in disregard of the fact that the profit per ton is the immediate aim of sagacious mining and the total profit on the mine as a complete operation is the object of a far-seeing owner of such property. It has been discovered, in London and at Johannesburg, how little a low cost per ton necessarily contributes to the amount of the dividends, if a low figure of cost is concomitant with a low yield of gold, that is, if tonnage be gained at the expense of grade; so now an effort is made to improve the grade, reduce the tonnage, and increase the profit per ton. This is a proper policy, when not carried to the point of spending more energy in discarding waste than is incurred in putting the waste through the mill. Moreover, the former scramble for tonnage has caused the erection of big mills and a demand for an output that some of the mines now find it difficult to supply. The clever men on the Rand have made some big blunders mainly because the policy adopted by them was shaped to please the exigencies of the share-market rather than to face the realities of technology and of conservative management.

ONE of the problems presented by the increasing application of flotation to ore-dressing is the treatment of the product, a watery concentrate containing oil. To Mr. Robert S. Lewis, Professor of Mining in the University of Utah, we are indebted for a timely and most interesting discussion of this subject. Our readers will recall with pleasure other writings from his pen, and will find in his latest article those evidences of literary skill and scientific observation that combine to make his contributions to technology so welcome. Indeed, no subject is more interesting just now than the disposal of flotation products—there is so much and so many of them! A great demand exists for information concerning either the preparation of them for shipment to the smelter or for their treatment in the locality where they are made. Professor Lewis discusses first the dewatering of the concentrate, and in this connection he speaks concerning the moisture permissible in flotation-concentrate to be transported on ships. While no definite proportion of water is specified, it appears that the concentrate must not be sloppy; it must be firm enough not to go awash. Different methods of draining the concentrate before shipment are described, including filters, thickeners, drying-floors, vacuum-pumps, and steam-pipes. A large number of examples of successful filtering are recorded, with practical details of the utmost usefulness. The next difficulty is the smelting of the concentrate, the increasing output of which, as our readers are aware, has made so great a demand on reverberatory furnaces as to diminish the relative utility of the blast-furnace in copper smelting. This difficulty, of course, is physical, not chemical, due in part to the wetness but more largely to the fineness of the material. Sintering of the concentrate before reduction in the blast-furnace is a step no metallurgist likes; at best it is a dirty and inefficient process. Therefore reverberatory practice is preferred. This applies to lead and copper products; the zinc smelter finds troubles of his own. Drying in kilns and roasting in muffles or in open-hearth furnaces are among the preparatory methods adopted. Loss in dust is the chief bugaboo. No wonder the smelter superintendents call this new metallurgical product "a damned nuisance." But more and more of it is going to be produced in the near future, therefore it remains for the skilful technician to accept the situation and make the best of it, as, of course, he will. The examples of smelting practice given by Professor Lewis are peculiarly interesting.

David H. Browne

With infinite regret we record the death of David H. Browne, who, on March 30, succumbed to complications following an attack of influenza. He could little be spared at any time, least of all today, for he was an engineer that gave expression, in his life as in his writings, to the highest ideals of the profession—to those ideals that make the engineer an intelligent, patriotic, and clear-sighted citizen. David Browne was born an Irishman and came to the United States when a boy of sixteen. He graduated from the University of Michigan and began his professional career at the blast-furnaces of Ohio. In 1891 he entered the service of the Canadian Copper Company and since then he has been identified with Canadian metallurgical practice. In 1916 an honorary degree was conferred upon him by Queen's University, at Kingston, this event serving to mark his high place among the most thoughtful and responsible members of the engineering profession in North America. During the last twelve months he contributed several characteristic articles to the bulletins of the Canadian Mining Institute, and in all of these he showed the combination of idealism, good sense, and humor that made him so lovable a character. In our issue of March 27, 1915, we published the text of a speech made by him on the occasion of a medal being presented by the Mining and Metallurgical Society to Mr. Robert H. Richards. The present writer heard that speech; it was a splendid appreciation of a man after Browne's own heart, and he, in expressing his admiration of the medallist, gave voice to his own notions of service and of conduct. The tribute to his friend was worth more than any gold medal. On that occasion he said: "The greatest thing in life is personality. The greatest men are those whose fingers find the chords of life and at whose touch we thrill in sympathy." He touched those chords, he struck a strong clear note, and the echo of them shall not willingly be let die.

Group-Insurance

Esprit de corps! That is at the bottom of the recent remarkable development of group-insurance. It intensifies the consciousness of co-operative effort on the part of capital and labor toward an economic result, because of the proportionate benefit that it yields to the several participants. It thus becomes a true vitalizer of industry. The action of the American Smelting & Refining Company in undertaking to carry such insurance for its employees in a most notable instance in the mining world in which this later phase of profit-sharing has been adopted. During the year 1916 the company paid $31,000 in premiums for group-life insurance covering the lives of all day-laborers who had been continuously on the pay-roll for one year or more at eight plants. The company has now made the plan general throughout all of its mines, mills, and metallurgical works in the United States, and has assumed the liability on its own account, issuing certificates to every workman, regardless of race, age, or physical condition. The single requirement is continuity in employment. This adopts the essential feature of the plan of group-insurance that commended the system so promptly to the acceptance of both employee and employer; it is reward for service, not a bonus, nor a gift; it has nothing to do with profit-and-loss accounts; it does not fluctuate with the market; nor may it be minimized by absorption of corporate earnings in ways known to the financier. It avoids the common pitfalls of profit-sharing devices wherein the wage-earner is thrust into the position of a partner without a voice in the management, yet subject to shrinkage of income in the face of decreased earnings set forth in the balance-sheet that he but dimly understands and quite frankly distrusts. Behind all this lies the lack of education in the wise uses of income that has militated against the success of profit-sharing. Teaching to save is barren of results compared with instruction in necessary and productive expenditure. As between saving and growth the difference is antipodal. The appeal of group-insurance lies in its recognition of the value of continuous service *per se* and in the rights to the cumulative inherent benefits; it has caught the imagination of that vast majority that has laid up nothing for the future nor made provision for the welfare of wives and children when death shall cut off the daily wage. Insurance statistics show that 89% of all men at death leave nothing behind. To these people the insurance certificate offers a new ideal: protection to the family through steady devotion to duty. The plan adopted by the great smelter corporation is practically identical with that developed by the Equitable Life Assurance Society, on the basis of which group-insurance for various corporations is being carried for an aggregate sum of over $100,000,000. The Union Pacific Company alone has taken out $35,000,000 of such insurance this year for the benefit of its employees.

Effective from January 1, 1917, the American Smelting & Refining Company obligates itself to pay to the heirs of an employee dying while enrolled in its service the sum of $1000 in the case of a married man, and $500 in the case of a single man. The term of the certificate is one year only, but at the end of each year for the ensuing five years new certificates will be issued, increasing the amounts of the indemnity $100 and $50 respectively, until the indemnity of married men will be $1500 and that of single men $750. This applies to wage-earners alone. The salaried employees receive certificates of indemnity in sums equal to one year's salary in each case, with a maximum limit of $10,000. The company will set aside sums each month to create a fund sufficient to carry the indemnity after the manner of the legal reserve in ordinary insurance, but the wage-earners' indemnity will be taken up in the general expenses of each plant. It would, therefore, seem to be the purpose of the company to re-insure continuously the wage-earning group with the regular insurance companies that take this class of risk.

The principle of group-insurance is similar in some respects to that of fire-insurance. The risk is of short duration; the law of averages applies by taking the age-factor into account, irrespective of physical condition. The estimate of the liability is revealed from the rate charged by insurance companies, this being approximately 1¼% on the annual pay-roll, where groups of more than 100 employees are protected. Group-insurance lies apart from so-called welfare-work; it is part of the business program, not of the charity organization, of the corporation. Labor efficiency is said to vary from 20 to 80% of that which might be delivered under the stimulus of the highest interest and resolve of the workers. Average efficiency is rated at 60% of that normal to free-will labor. If this be raised 5% by the issuance of indemnity certificates the gain in productiveness above the cost of such insurance yields a profit to the enlightened corporation utilizing the system, and it increases the assets of the nation in like proportion. The verdict of companies that have had experience with the plan is that an estimated efficiency greater than 5% may be credited to its influence. The certificates develop a new bond between the individual and the social group; for the first time in his life the ordinary wage-earner becomes a creditor, with society voluntarily admitting itself his debtor and putting a bond of indemnity into his hands. In many cases these certificates constitute the only valuable paper the workman has ever owned; it is not uncommon to see them framed and hanging on the walls of the home. Group-insurance has not solved the problem of harmonious co-operation between labor and capital, but it is a long step in the direction of bringing the worker into comprehension of the meaning and value of capital as surplus labor stored for use and as a provision against future calamity or want. Esprit de corps, the group interest, the group effort—this is the foundation of solidarity in human endeavor. In group-insurance this important principle is operative, and this commends it as one of the most practical advances in the rational socialization of industry.

State Mining

If a proposal were made to operate the copper mines of the Keweenaw peninsula under the direction and for the benefit of the State of Michigan or to exploit the gold mines of the Mother Lode region in the interest of the State of California, what would you think of it? This question is prompted by the fact that a Mining Commission has been in session at Johannesburg to collect evidence concerning the advisability of enacting laws that would authorize the government of the Transvaal to operate the gold mines of the Rand. All sorts and conditions of men have expressed their opinion before the Commission. Mr. F. A. Unger, a consulting engineer, testified that in Holland the idea of State mining was introduced in order "to increase production and to prevent foreign capital getting too big a hold." He thought that "in an unsettled country like South Africa there is danger of political jobbery." That might happen in Michigan or California. We cannot conduct our State Mining Bureau without "political jobbery," can we? Mr. Unger said that "State mining in Holland was brought about by necessity, but no such necessity exists" in the Transvaal. Luckily, no such necessity exists in Michigan or California. Messrs. Evans and Ross, speaking for mine employees, said that "technical brains are just as available to the Government as to private employers if it pays the necessary salaries." Governments do not pay the salaries necessary to retain such men as are at the head of big speculative or industrial enterprises. The brains gravitate rather to Wall Street than to Pennsylvania Avenue. The manager of the United States Navy is not to be compared in mental vigor with the manager of the Bethlehem Steel Corporation. The restrictions to unlimited gain imposed by Government service are uncongenial to the keen and energetic type of man who usually directs the operations of a big mining or smelting enterprise. The same witnesses asserted that "greater security of tenure of employees would be an incentive to good service." Not in this world as now constituted. Insecurity of tenure prompts most men to work hard in order to win approval from their employer or chief. Sir George Albu, an experienced administrator of mines, was emphatic in his opinion that "the working companies so far have greatly benefited the country—more than the State could. The companies have benefited the country more than themselves." If they have, it was unintentional, one may be sure, for the big mining corporations were not organized on a philanthropic or even a social basis. The social instincts of individual operators, like Eckstein and Taylor, or the big political ideals of sundry financiers, such as Rhodes and Beit, were no part of the scheme of mining, which was to make money for shareholders in England, Germany, and France. "Mining is always risky," continued Sir George. That is true, and it is a truism that the State would be prompt to recognize. Indeed, the State would not be likely to take the risks that the individual or the syndicate faces willingly. State mining is bound to be timorous because State officials would not be in a position to indulge in speculative ventures to the same degree as the promoters and adventurers to whom the expansion of mining is largely due. The dread of criticism from an untechnical public would paralyze the initiative of a State director of mining and his coadjutors. "If the State were to mine, a good many political followers would have to be considered." Yes, we can tell Sir George that even a State Mining Bureau or an office of State Geologist cannot be conducted without considering political followers. As now organized such bureaus are of minor importance, but if they were to be given the authority to control the mining of the State, what would happen? The mere imagination of the consequences is a nightmare of political wire-pulling and subservience. On the Rand, Sir George Albu predicted, it would mean a demand by the labor-unions to expel the Kaffirs from the mines and to employ white labor only.

"That would spell absolute failure," he added. His opinion of State mining was summarized in a proverb: "Fools rush in where angels fear to tread." He testified that the 'mining houses' had sold their shares, which had been absorbed largely by the public in South Africa. "The Rand is not paying more than 10%. Without speculators there will be no mining business. The advocates of State mining do not appreciate the dangers and difficulties." He quoted large expenditures on mines that had proved unprofitable, but he had not much to say concerning the big 'killings' made by himself and other promoters in the halcyon days of the Rand when shillings were turned into pounds by lucky speculators—"not 'gamblers'," Sir George interrupted heatedly when somebody present referred to "investors in mining ventures" as 'gamblers'—so says the report of the proceedings. We agree; they are neither 'investors' nor 'gamblers,' but 'speculators' in a necessarily venturesome business, and if their methods are not always legitimate that is not a defect inherent in mining, but in the sort of people to whom mines are counters in a game that is not always played fairly. Mr. E. F. Bourke, of the Pretoria Chamber of Commerce, thought that "gold mining is too risky an undertaking for the State." He said that "the tendency of State mining will be to make mining industrial and eliminate the speculative element." That would kill it; the vitality of mining depends upon the red corpuscles of adventure; the exploratory instinct is essential. When mining becomes industrial it is senile. Mr. C. F. Tainton suggested that in South Africa the limits of private mining had been reached. The ground remaining undeveloped offered too small a margin of profit for private enterprise. Was the gold to be left in the rock for all time? If private capital demanded 9% return above the 10% profit-tax, it would refuse to work such areas, while the State, which could work advantageously for 4% and the return of its capital, would have a margin of 5 shillings per ton—or enough to bring immense new areas within the requirements of profitable exploitation. Indeed, the State could afford to work without profit, because so large a part of the money spent would remain in the country and become subject to taxation. The verdict of competent enginers, said Mr. Tainton, was that within eight years only 33 of the existing mines would be producing gold and within fifteen years the output will have fallen to less than £20,000,000 per annum, or about one-half what it was in 1916. The value of property in South Africa will decline "hundreds of millions" of pounds, if the chief industry of the country is not supported. In ten years, added Mr. Tainton, there has been a drop of 40% in the value of property around Johannesburg. Mr. Kenneth Austin thought that the work now required to develop a group of claims of suitable size involved too much capital for any company of citizens; it should be undertaken by the State. At least "the State should do some of the heavy work, and the citizen could do the remainder." The State Mining Department should be organized like the existing State Railway Department, he thought. As to the suggestion that it was better that the individual should bear the loss incurred in mining than that the State should suffer, he insisted that "the loss is an economic loss, whether borne by a State or a person; no sophistry could obscure the fact that £500,000 wasted in digging useless holes was an economic loss and the net effect the same." Of course it is; the labor that is spent unproductively is squandered.

Mr. D. Wilkinson, consulting engineer, considered the proposal "utterly nonsensical." Mr. Henry Adler was anxious to see the mines owned and operated by residents, he would like to see the Government raise capital in South Africa for working two promising areas, which he defined, and it was his belief that the workers would invest in the debentures issued for such a domestic enterprise. Mr. William Hosken, a merchant, quoted the axiom that "the national estate should be used to the best advantage"; therefore he favored State mining. If the whole area were exploited, mining risks would be reduced to a minimum, he said; and so would be the profit, we suggest. He recognized the difficulties and specified "gerrymandering, excessive wages, political power of voters so engaged, Government 'stroke'," meaning by this last the deliberation that marks the work of a Government employee. Being an optimist, he thought these evils could be corrected. Most of us do not. The administration of the State Railways in South Africa does not encourage such expectations. Mr. Hosken argued that the State could obtain capital at a lower rate of interest, say, at 6%. So it could, but it would endanger its credit by engaging in essentially venturesome business on such a low return. The same witness suggested that the profit from State mining should be used to reduce the national debt, but he is counting his chickens prematurely; if the State exploited the low-grade areas now lying idle—and that is the idea—it would need all the profit in one mine for development in another. The idea of employing convict labor was distasteful. Mr. J. H. Munnick, mining engineer to the former Transvaal republic, said that the late Government worked the Rand as a State mine during the Boer war "with very successful results." By opening up new mines while the old ones were being worked out, the industry would pass automatically into the hands of the State; "it would be criminal to miss the opportunity." Mr. J. G. Lawn, a distinguished engineer, did not think that "would work as well for the Government as for a private company." The pace was quite different. Mr. C. B. Kingston, another mining engineer of high repute, suggested that the State would do better by encouraging new enterprises than by going into mining itself. Engineers in charge of existing State mines found their work hampered by political considerations, leading to the employment of undesirables. "The proper function of the Government was to create, by wise legislation, conditions best calculated to stimulate private enterprise. To use the revenues of the community was to cramp and discourage individual initiative and waste the finest asset a community could possess." Let us leave it at that.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

C. A. Bentley v. American Metal Co.

The Editor:

Sir—We do not ordinarily go to the trouble to deny misstatements which appear in print in the daily papers, but our attention has been drawn to an article which appeared in your issue of February 17 from your correspondent in El Paso with reference to a suit brought there by C. A. Bentley against our company for breach of contract. Your correspondent's report of this litigation is so inaccurate and reflects upon us in such a way that we cannot permit it to pass uncorrected. The facts are, as clearly proved at the trial, as follows:

A contract was made with C. A. Bentley, acting as president of the San Roberto Mining Co., on the one hand, and one H. A. Houser, as president of the Compañia Minera y Compradora de Metales, on the other, for the purchase by the latter of 10,000 tons of zinc ore from the San Roberto mine. Mr. Houser endeavored to sell this ore to the Compañia de Minerals y Metales, Compañia Minera de Penoles, and ourselves, but all of these companies refused to purchase it because of its exceedingly low grade, the material running less than 25% zinc.

Houser then notified Bentley that his company could not handle the ore and that at the time he made the contract in the name of his own company he did so as our agent. When Bentley threatened suit, Houser told him that it would be useless to sue the Compañia Minera y Compradora, as it was financially irresponsible, and that the only way he could recover anything was by joining the Compañia de Minerales y Metales, the Compañia Minera de Penoles, and our company as co-defendants. As a further evidence of the agreement between Bentley and Houser, Houser admitted on the stand that the day before the trial the suit against his company had been dismissed, which was apparently to be his reward for testifying against us.

Each of the defendant companies denied absolutely that Houser had any authority to act for them as agent, and there was not a scrap of evidence offered, outside of Houser's own testimony, to show that any of our companies had made the contract or had authorized any one else to make it on our behalf.

So far as the Compañia de Minerales y Metales or the Compañia Minera de Penoles was concerned, no serious attempt was made to fix responsibility upon either of these companies, the attorneys for the plaintiff only asking to submit to the jury the question of whether or not our company was responsible for the contract which Houser had made. On this question, the jury found against us and awarded Bentley damages of approximately $60,000 to cover alleged profits which he would have made had the ore been shipped and paid for under the terms of the contract. No serious fight was made by our attorneys on this question of damages, as they were convinced that there had been an absolute failure of proof to connect our company in any way, through agency or otherwise, with the making of the Bentley contract. An appeal has been taken from the judgment entered on the verdict of the jury, and we have every intention to prosecute this appeal to the highest courts in the State.

We have no desire to try this litigation in the press, nor do we even care especially to have this statement of the facts published. We do care very seriously, however, to have ourselves placed in the proper light in the eyes of the gentlemen who are editing publications, such as the MINING AND SCIENTIFIC PRESS, which reach the hands of so many of our friends in the metal business.

OTTO SUSSMAN, Vice-President,
The American Metal Company, Limited.

New York, March 15.

Caustic Soda in Flotation

The Editor:

Sir—Several letters regarding the use of caustic soda in flotation have appeared recently in your paper. In connection therewith it may be of interest to know that since October 1916, caustic soda, to the extent of 1.3 lb. per ton of solids treated, has been used in flotation at the Old Dominion Copper Mining & Smelting Co.'s concentrator at Globe. The flotation-feed comprises the total mill-slime, consisting of 44% of the mill-feed. This contains on an average of 25% minus 200-mesh material and 75% plus 200-mesh. The mill-feed contains 13% minus 200-mesh material which may be called 'primary' slime. The average analysis of the general mill-slime follows:

	%		%
Cu	2.6	CaO	1.5
SiO_2	55	S	4
Fe	8	Al_2O_3	17.5

It will be noted that the flotation-feed contains a high content of clayey material. That caustic soda has a marked de-flocculating action is evidenced by (1) the difficulty experienced in the settling of the flotation slime-tailing in the settling-ponds; (2) the lessening of the insoluble content of the flotation-concentrate produced; (3) the increased extraction caused in part by the de-flocculating action on the mineral-content of the

very fine slime. A further benefit obtained in the use of this reagent is its chemical action on the water in the flotation pulp. This water contains approximately from 10 to 15 grains per gallon of bicarbonate of lime, $H_2Ca(CO_3)_2$, and may be called fairly hard water. The addition of caustic soda to the flotation slime-pulp brings about the instant precipitation of finely precipitated carbonate of lime, in accordance with the reaction:

$$H_2Ca(CO_3)_2 + 2NaOH = CaCO_3 + Na_2CO_3 + 2H_2O$$

The elimination of this lime carbonate from solution, and the presence of sodium carbonate in solution, unquestionably brings about increased efficiency in the flotation work at this plant. The use and effects of this reagent at the Old Dominion concentrator emphasize the point that in many cases the proper use of acid or alkali is of great importance in the investigation of the conditions best suited for the flotation treatment of any particular ore.

W. B. Cramer.

Globe, Arizona, March 21.

Sampling Low-Grade Orebodies

The Editor:

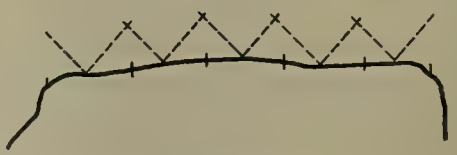
Sir—While this is a little apart from your recent discussion on sampling low-grade ore, it brings up an interesting case and a method that I have not happened to see described.

In low-grade orebodies sampling with the moil, even when carefully done, may be misleading unless the deposit is quite uniform. In case the ore occurs as bunches and veinlets through the country-rock, it is quite easy to 'salt' the sample, as frequently the ore is softer than the rock.

In the illustration shown, a proportion of the back of a large stope was sampled by moil, giving an average result of 2.81% copper, this result being checked by several previous moil-records by different engineers. As this block was near the surface it had been stripped and was being worked as a glory-hole, so it was easy to check the actual record obtained by the previous method of sampling. When mine operations were started in this special block the mine-samples had indicated very low-grade, but it was assumed that this might well be a portion of extra poor ground as the stope in any event was most irregular. As the stope was being conducted on a fairly large scale, several hundred tons that averaged 1.77% were mined before deciding to stop the work at that place. It was then decided to check the previous sampling, as the back below was still accessible, and especially as our operations had given a rather startling difference from the sample record.

We wished to do this cheaply and quickly; the ground being hard, moil-sampling would have been slow and expensive, so we decided to try a stoper-drill, which we found to be a cheap and accurate method of sampling low-grade ore. The mechanical arrangement is simply an ordinary stoper with a canvas bag to catch the dust, the bag being held open by an iron fork and the drill working through a leather washer in the side of the bag and the opening. The method of taking the sample is shown in Fig. 2, each inverted V constituting a sample.

Fig. 1.



Section of stope showing method of sampling with stoper.

Fig. 2.

Each hole is 5 ft. deep and the base of each triangle is 5 feet.

This method is not claimed as original; probably it has been widely used. It was suggested to me by Mr. Sharp, who had tried it out under Basil Prescott at Santa

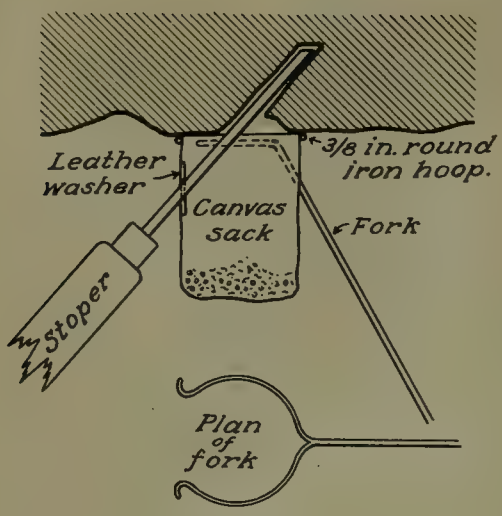


Fig. 3.

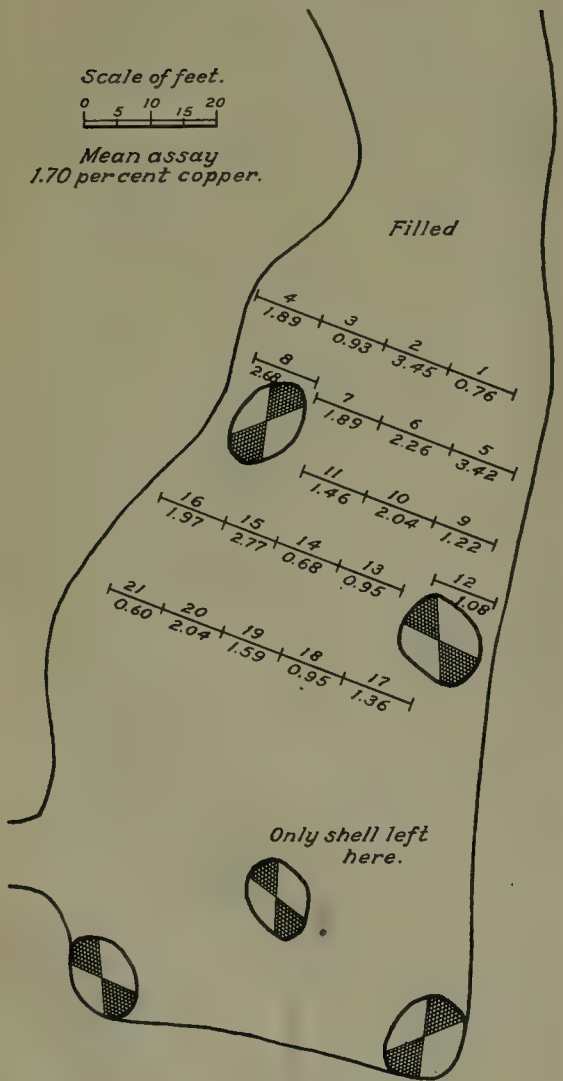


Fig. 4.

Eulalia. He used it to check a large series of moil-samples taken under the supervision of J. E. Spurr, resulting in practically a perfect check.

Edward Thornton.

Silverbell, Arizona, March 5.

Sulphur From Pyrite

The Editor:

Sir—From the editorial discussion in your issue of March 17 concerning the production of elementary sulphur from pyrite, I am left under the impression that M. G. F. Söhnlein refers to the experiments being made by H. F. Wierum and others of the so-called Hall process, in Australia, which was tried out at the Balaklala Consolidated Copper Co. some three years ago. The manager at that time was Frank M. Leland. Under an arrangement with the company owning the Hall patents approximately $125,000 was expended on the process, with absolute failure as the result. The only sulphur ever made was due to spraying steam into the McDougall furnaces, producing H_2S, and consequently metallic sulphur, and incidentally nearly suffocating the entire community. They claimed that water-gas made from crude oil was absolutely necessary. A gas-plant was built at a cost of about $60,000, large enough to serve the town of Redding, and it was standing there when the writer left, a monument of folly, and no doubt it has been sold as junk, as was most of the other equipment at the smelter, under the 'lost and found' supervision. I was employed to assist the manager and did so to the extent of preventing the payment of $150,000 for the use of this process at that time, and subsequently became the acting manager. To give the history of this abortive attempt would require a volume.

E. H. Wedekind.

Battle Mountain, Nevada, March 19.

[The Hall process depends upon roasting pyrite in a reducing atmosphere with the addition of steam, maintaining a temperature of between 600 and 900° C. The object is to oxidize metallic bases without oxidizing the liberated sulphur. This is evolved as sulphuretted hydrogen. By reacting with sulphur di-oxide all the sulphur theoretically should be freed from combination and pass off with the fume in the elemental form. It was collected from the furnace gases by the Cottrell method of electrical precipitation. The Hall patents were acquired by the Sulphur Syndicate, Ltd., of which Theodore J. Hoover became chairman, and the American, Canadian, and Mexican rights passed to the Federal Sulphur Co. The outcome of the experiments in Australia will be awaited with interest. Failure of a new process at one time does not preclude its later development into a useful and economic method.—Editor.]

Salt beds at Anse la Butte, near La Fayette, Louisiana, have shown a thickness of 3463 ft. of pure rock-salt, beginning at a depth of only 150 ft. below the surface. The deposit was tested by drilling. The Benners Salt Co. is erecting a plant to treat 700 tons daily.

FIG. 2. CROSS-SECTION THROUGH STOPES.

Losses Incident to the Caving of Orebodies

By R. G. SAMPSON

The caving-system has been extensively employed by some of the largest mines in the South-west, and it has played an important part in the extraction of the bodies of iron ore in the Lake Superior region. It is used particularly for the mining of low-grade, uniform orebodies for the reason that a large production may be had at a low cost per ton. That it is not usually applied to the mining of high-grade orebodies is in part due to a loss of ore which invariably attends its use. In the early days of its application it was generally believed that a large percentage of the ore would be lost through the unavoidable mixture of waste with the ore. This difficulty has been largely overcome in some places by the use of a 'timber-mat' that is introduced between the ore and cap-rock. Here the question of cost enters and this feature, in many instances, has been overlooked or misunderstood, as the operators appeared to think that the increased extraction would not justify the necessary expense. To illustrate the following remarks, the drawings, Fig. 1 to 7, have been prepared. The first three show how an orebody may be caved by the use of a system similar to that employed by the Ray Consolidated Copper Company.

In the description that follows only such details are given as seem necessary to make clear the points to be made. A detailed description of the system appears in the Transactions of the American Institute of Mining Engineers, for 1915, by L. A. Blackner.

Fig. 1 shows the plan of a level laid out for the caving of the ore above it. The proper position of the drift, which is driven around the edge of the orebody, was determined by means of drill-holes, as was all other preliminary information necessary for the intelligent application of the system. After, and during the driving of this fringe-drift, cross-cuts were driven completely through the orebody—in this instance 50 ft. apart—and these connect at each end with the fringe-drift. When these cross-cuts, represented by the full lines in

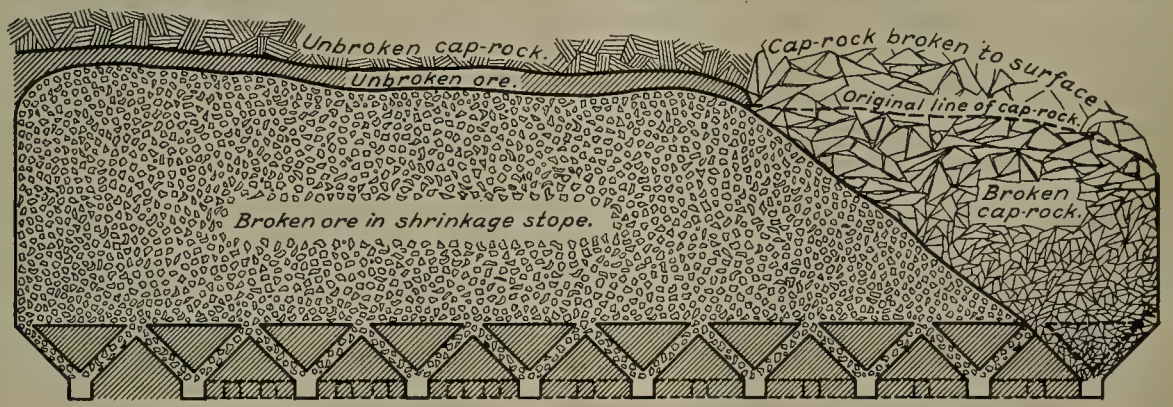


FIG. 3. LONGITUDINAL SECTION OF STOPES.

Fig. 1, have been driven and timbered, stoping will begin. The width of stopes and pillars will, of course, be determined by local conditions. Fig. 2, which is a cross-section through the stopes, represents an extreme case, where the alternating stopes and pillars are each but 10 ft. wide.

The stopes are carried up to within a few feet of the cap-rock by the shrinkage method. To permit this about 35% of the total ore broken in the stope is drawn while stoping is in progress. A raise is put up from each side of the several cross-cuts at an inclination that allows the broken ore to run freely by gravity. Each of these raises, as shown in Fig. 3, will connect upward with one from the next cross-cut. The raises are then connected horizontally and continuously by driving along the orebody, thus making a stope-back throughout the length of the orebody. Stoping then proceeds upward in the usual

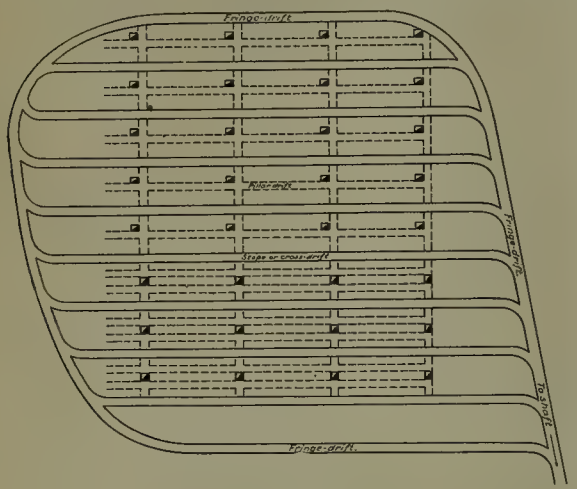


Fig. 1. PLAN.

manner. A thin strip of ore is left overhead, between the broken ore in the stope and the cap-rock, to prevent mixing in case there should be local caving of the ore and cap; also that it may act as a cushion for the cap, and prevent it from breaking into small pieces and thus obviating its becoming too intimately mixed with the ore. After all stopes in a block 200 ft. long have been completed and while they are still filled with broken ore, if it is desired to convert that block into a drawing-section, raises are cut in the pillars similar to the raises made preliminary to stoping. These raises are put in on both sides of each cross-cut, and if deemed necessary they may be connected by auxiliary raises driven from them and meeting over the cross-cuts. When the tops and sides of these raises have been drilled and blasted, the support of the pillar throughout its length will have been removed; the pillar then settles, and rests on broken ore. Later, when the stopes on both sides of a pillar, and the pillar-stope as well, have been drawn, the crushing force of the broken ore in the stopes, together with the weight of the pillar itself and that of the cap-rock above, so fractures the remnant of the pillar that the ore is readily drawn through the chutes on the level below without further blasting, except possibly an occasional bulldozing shot.

When all of the stopes and pillars, or parts of them, have been drawn up to the cap—that is, all of the ore having been removed from the stopes, including that of the pillars—drifts are driven through the wedge-shaped blocks left standing on the level. These drifts are indicated by the dotted lines in Fig. 1. Chutes to the level below are conveniently placed, at intervals of 100 ft., and chutes for drawing the ore from the pillar are built in every set in the drift. A few holes blasted in the pillar, just over a chute, usually suffice to start the caving. When the stopes have been exhausted, the lagging on the sides of the drifts near the chutes connecting with the next level, may be removed, and the small pillar still standing (see Fig. 7) can be caved directly into the chutes.

The drawing of ore from the stopes and pillars is an important part of the ultimate success of the system. As it is impracticable evenly to draw all of the ore in the stopes and pillars over so large an area at the same time, and in a manner that would allow the cap to settle somewhat uniformly, drawing is begun in three or four drifts at the end most remote from the shaft—a section about 100 ft. long in each of these drifts being opened for drawing. The stopes nearest the 'back fringe-drift' will be drawn on most heavily, and these will be first exhausted. As this condition is approached, new stopes nearer the 'front' fringe will be drawn. This process is continued until all the ore in the stope has been removed. Drawing the ore by this system keeps the cap sloping in two directions, as shown in Fig. 2 and 3, an effort being made to keep the slopes as uniform as possible, without local humps or depressions.

As there is such a small margin of value between ore and waste, constant vigilance is required to prevent drawing the cap-rock filling with the ore. When the ore in a stope has been almost all drawn, small pieces of cap, which have been ground up as the rock settled, will work in and come through the chutes with the ore. These pieces of waste gradually increase in number and size until a point is reached where the mixture cannot be handled at a profit; the stope is then abandoned, and any ore that remains in the stope is lost. This is unavoidable, but usually it is only a small part of the total ore of the block. When drawing from this stope is begun in the next drift, should the ore become jammed above the drift, as frequently happens, the cap over the drift already drawn may work in under the ore. However, when the stope was active, samples were taken every few feet along the back, throughout its length and height, and these, together with the cross-section and height of the stope supplied data necessary to make an estimate of the amount and the grade of ore that should come from it. Should a stope run waste before the estimated amount of ore has been drawn from it, an investigation is made, and while the cause may be discovered, frequently the amount of waste that would have to be

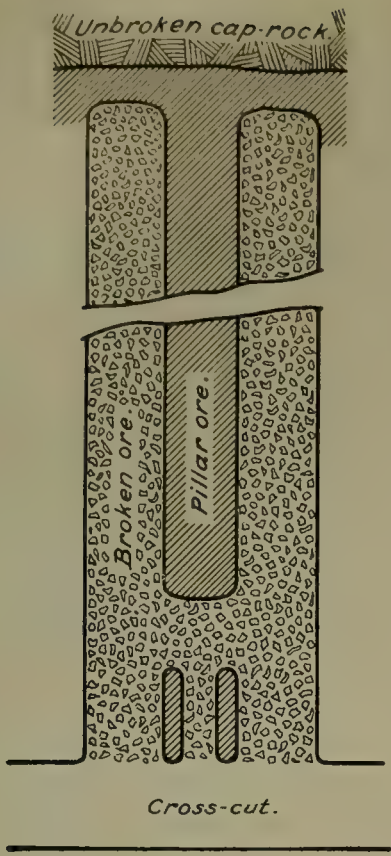


FIG. 4. CROSS-SECTION OF STOPES AND PILLAR READY FOR DRAWING.

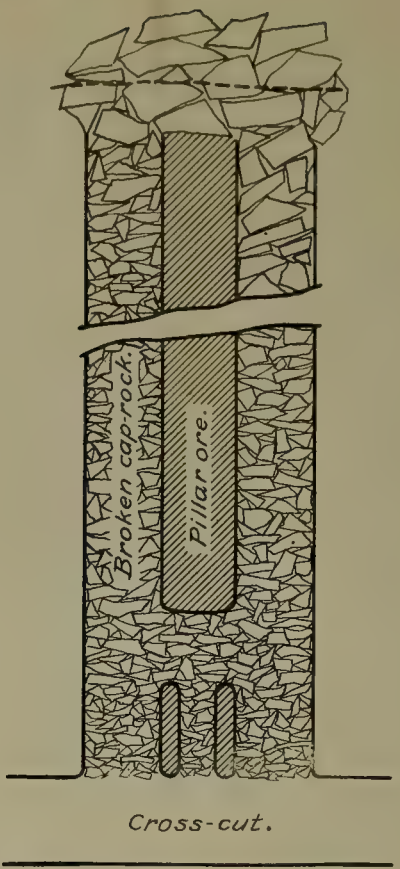


FIG. 5. CROSS-SECTION OF STOPES AND PILLAR AFTER DRAWING.

handled would be too great to warrant the removal of the contents of the stope to get the ore that remains.

Here then, are two sources of loss, one of them invariably exists, the other occurs occasionally. A far more serious loss may result in the extraction of the pillars. When a pillar is blasted it frequently happens that holes are blown into the stope on either side of the pillar. After the blast a few cars are drawn out to ascertain if the pillar is 'down.' If so, it is left undisturbed until ready to draw. When drawing is begun the pillar-stope is drawn upon more heavily than the stopes on either side of it, the idea being to let the pillar settle and crush itself. At the time of the preliminary, or test drawing, of the pillar, if, after 60 or 70 cars have been removed, the raise is still full of broken ore, it is assumed that the pillar is undercut and settling down.

When the drawing begins in earnest, ore is taken from the stope-raises and pillar-raise at the same time. The holes connecting the pillar-raise with the stope will permit the broken ore from the stope to be drawn through the pillar-raise. This ore, which is well broken, will run freely and will afford some support for the pillar, which then has not chance to cave. The existence of this condition cannot be determined until the stopes and pillar-chutes run waste, when it will be seen that the tonnage is considerably less than it should be, but it is then too late to apply a remedy, as a large area of cap would have to be removed before the pillar would cave.

Fig. 4 and 5 illustrate a condition of this kind. It is the practice to put the pillar-raises up on a somewhat steeper inclination than that of the stope-raises, so that

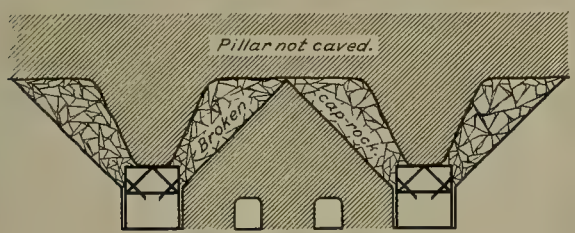


FIG. 6. SECTION THROUGH PILLAR-DRIFTS BEFORE DRAWING.

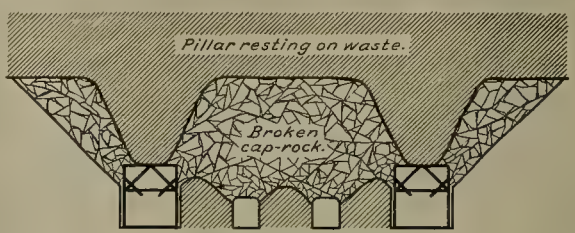


FIG. 7. SECTION THROUGH PILLAR-DRIFTS AFTER DRAWING.

the holes into the stope-raise are at the top of the pillar-raise and at the bottom of the stope-raise.

By reference to Fig. 6 and 7, it will be seen that it is impossible to get the ore from this pillar from the pillar-drifts that are subsequently driven on the level below. When the small pillar on the level has been exhausted the waste from the pillar-stope (underneath the large pillar still standing) will appear in the chutes, and these then will be abandoned.

To obtain the estimated tonnage, and to be sure that no ore is left, drawing may be continued even after the economical point of mixing of the ore and cap has been reached. The amount of rock drawn from the chutes is increased by the presence of the waste, but the metallic content is decreased. If, by means of drill-holes, there had been blocked out a stated number of tons, having a determined metallic content, when a stope has been worked out, if the total calculated tonnage has been extracted, will the average metallic content be as high as was estimated? Would it not be better to leave some of the ore than to try to take it all, including the part mixed with waste? The grade of ore would be the governing factor in answering these questions.

What percentage of the total ore can be extracted free from waste? This is another of the many questions that have to be answered by one who proposes to mine with the caving-method. There are many forms of caving; in fact, almost every mine, where the system is used, has introduced some original feature. In the Tobin iron mine, at Crystal Falls, Michigan, a system of raises on 16-ft. centres, 'staggered' along the sides of drifts driven on 50-ft. centres, are put up and the tops flared out until they connect. The back left is then drilled and blasted. The entire block above is thus started caving. The weight of the broken cap completes the crushing process, and caving takes place in the form of sloughing.

The ore at the Tobin mine is hematite, which contains from 56% to 60% iron. It occurs between a bed of ferruginous cherty slate and one of carbonaceous slate. The former is called the hanging wall, and grades into ore by the loss of silica. There is no well-defined line between waste and ore and this necessitates much care and vigilance in the extraction of ore by the caving-system.

A description of the caving-system used in various mines, the cost of production; the percentage of ore lost; the saving effected by the use of a timber-mat, and the evolution of the present system at each mine, together with the reasons for the various changes from the original method would make interesting and instructive reading.

Bureau of Standards—Screen-Scale

Uniformity in technical statement facilitates interchange of data and their correct interpretation. Screen-analyses often lack the value that should attach to them, by reason of the diverse standards used. Unless the exact size of screen-opening is known the relation between undersize and oversize is not significant to the metallurgist. The successive sizes of screen-openings must be based upon some exact mathematical relationship in order that the successive over-size quantities may be of service to the operator in solving problems of treatment. Neither does the cumulative curve deduced from the grouping of the successive over-size products furnish a valuable guide unless the ratio of successive screen-openings is dependent on a law which gives a true mathematical curve. None of the proposed standard sets of screens has withstood criticism. As a matter of convenience, and to avoid confusion, mill experimenters have quite generally taken advantage of the Tyler set of screens made especially for this purpose. These are based upon the specifications of von Rittinger, in which the diameters of the successive sizes have a constant ratio of 1.414, that is, the square root of 2, while the areas of the successive openings have a constant ratio of 2. The Bureau of Standards of the Department of Commerce now proposes a standard screen-scale for testing-screens, recommended for common use after having been adopted by a conference of representatives from the American Society for Testing Materials, the American Society of Civil Engineers, the American Institute of Mining Engineers, and other societies. The scale is based on an opening of one millimetre. Sieves in the series with larger openings than 1 mm. are related to the unit-size by a constant difference in diameter of openings equal to the square root of 2 or 1.4142, while the finer sizes in the series of screens, having openings less than 1 mm. in diameter, differ by a constant equal to the fourth root of 2 or 1892. Details of the series from an 8-mm. diameter of opening to 0.044-mm., making 25 screens in the set, are shown in the accompanying table.

BUREAU OF STANDARD'S SCREEN-SCALE

Opening, mm	Mesh	Wire diam., mm.	Ratio diam. to opening	Tolerances Mesh	Tolerances diam., mm.
8.00	1	2.00	0.25	±0.01	±0.08
5.66	1.4	1.48	0.26	±0.01	±0.08
4.00	2	1.00	0.25	±0.02	±0.05
2.83	2½	0.81	0.29	±0.02	±0.05
2.00	3.9	0.56	0.28	±0.04	±0.05
1.41	5	0.59	0.42	±0.08	±0.025
1.00	7	0.43	0.43	±0.15	±0.020
0.85	8	0.40	0.47	±0.2	±0.015
0.71	9	0.40	0.56	±0.3	±0.012
0.59	10	0.41	0.69	±0.4	±0.012
0.50	12	0.33	0.66	±0.4	±0.012
0.42	14	0.29	0.69	±0.6	±0.010
0.36	16	0.26	0.72	±0.6	±0.010
0.29	20	0.21	0.72	±0.8	±0.010
0.25	23	0.185	0.74	±1	±0.008
0.21	27	0.16	0.76	±1	±0.008
0.17	31	0.15	0.88	±1	±0.008
0.14	39	0.116	0.83	±1	±0.008
0.125	47	0.089	0.71	±1.5	±0.008
0.105	59	0.064	0.61	±2	±0.008
0.088	67	0.061	0.69	±2.5	±0.005
0.074	79	0.053	0.72	±3	±0.005
0.062	98	0.040	0.65	±3.5	±0.005
0.052	110	0.039	0.72	±4	±0.004
0.044	127	0.035	0.80	±5	±0.004

The Disposal of Flotation Products

By ROBERT S. LEWIS

Introduction. A little over two years ago, I was talking with a mill-man from a certain plant where the flotation process had recently been introduced. To my inquiry regarding the success of the flotation equipment, he replied that, at first, it was impossible to obtain a froth. Then suddenly, due to some reason not understood, froth began to form so rapidly that it soon ran over the machines and piled up in great heaps on the mill-floor. It was of such a tough and lasting nature that it would have been an excellent substitute for sole-leather, and it was practically impossible to handle the concentrate because of its stickiness. These statements may contain some exaggeration, but they indicated that a mill-operator's troubles might not cease as soon as a froth was produced. Despite the improvements that have been made in the technique of the flotation process, the satisfactory handling and disposal of flotation concentrate is still a very important problem. In order to secure the latest data on the practice of handling flotation concentrate, a number of letters of inquiry were sent to companies operating mills or smelters. Nearly all the information given below is the result of this investigation.

Dewatering Flotation-Concentrate. This step is necessary as a preliminary to subsequent handling and metallurgical treatment. The large amount of water present in the froth must be reduced greatly before the concentrate can be transported economically, either in sacks or in bulk, to its destination. If shipped a long distance, the freight charge on the moisture contained may reach a considerable figure. The expense for unloading wet and sticky material from cars is much greater than usual. Then, too, custom-smelters often impose a penalty for moisture in excess of a specified figure. It is interesting to note that steamship companies refuse to carry a flotation concentrate that is very wet. Such materials shift so easily that it is impossible to keep the vessel on an even keel. After one ship had been lost, due to shifting of the cargo, steamship companies refused to transport concentrate in which the moisture ran over a stipulated amount.

When the froth is delicate and breaks easily, as does much of the froth from flotation-machines using only air-agitation, a simple treatment on a concentrating-table of the Wilfley type may give satisfactory results. However, it is generally necessary to employ some additional means to insure disintegration of the froth. Centrifugal pumps have been used with success. Bucket-elevators are fairly efficient, but unless included in the original design of a plant, are hardly to be recommended. At the Utah Apex mill, an elevator 71 ft. high is used to assist froth-breaking. Head-room and floor-space may be saved by using a jet of water instead. Experience has shown that a single large jet, spreading over the full width of the concentrate-launder is to be preferred to a number of smaller jets. In the Daly Judge mill, at Park City, Utah, a patent nozzle, known as the Koerting spray, has been found effective in 'killing' froth. After passing the spray, the concentrate is thickened in Callow cones and is then treated on Wilfley tables to separate the lead from the zinc. The objection to the use of sprays is that the additional dilution of the concentrate means so much more water to be disposed of later. Moreover, where settling-tanks are employed, any appreciable current in the overflow carries out a considerable amount of the finest concentrate. In an endeavor to overcome this objection, Messrs. Cole and Thompson have devised a special nozzle (U. S. patent 1,180,089, Aug. 18, 1916), in which a gaseous liquid, such as compressed air or steam, is mixed with a small amount of water. The resultant jet has a whirling motion. The spray should be directed against the flow of froth and at an angle of from 60 to 90° with the bottom of the concentrate-launder This retards the progress of the froth and gives the jet more time in which to break it up. The nozzle should be placed at such a distance from the launder as to allow the spray to cover the entire sectional area.

Settling in bins or tanks is a method of dewatering froth that has the merit of simplicity, although it has several disadvantages. Some flotation-concentrate is so fine, all – 200 mesh and with a large percentage of – 300 mesh, that the time required for settling is prohibitively long. Where a large tonnage must be handled the size of the equipment becomes serious. This point is well illustrated in the case of one of the big copper concentrators. An estimate showed that a number of concrete tanks 20 ft. wide, 108 ft. long, and from 5 to 6 ft. deep would be required. The proposed method of operation was to run the froth into a tank until the overflow should become contaminated by the fine concentrate carried over. The tank-feed was then to be cut off and the content settled. The clear water was to be decanted and the concentrate allowed to dry for a day or two. However, the tanks were never built, thickeners and filters being finally adopted. Tanks may have either filter or solid bottoms. In the first case, vacuum-pumps can be used to hasten draining. When solid-bottom tanks are used, the water must be decanted from the settled concentrate, and care must be taken not to allow the escape of the froth, which almost invariably accumulates on the surface of the water. Unless of special design, such as those arranged for a Blaisdell excavator, tanks must be unloaded by shoveling. If desired, the tanks may be provided with steam-pipes to assist drying, but their use

is hardly to be recommended. Spreading the material out in a thin layer on a drying-platform gives quicker and better results, but, in any case, drying by steam-heat is expensive. Classifiers of the Ovoca and Akins type have been used for dewatering concentrate. These are quite successful on coarse or granular material that drains readily.

The following examples illustrate the practice of settling flotation-concentrate in tanks or bins.

1. The Desloge Consolidated Lead Co., Desloge, Missouri, has been drying its lead concentrate to 6 or 7% moisture in steel drying-tanks, heated by steam, and then loading it by hand into unlined box-cars. The method is expensive, and the company will soon install a thickener and filter.

2. Monitor Belmont Mining Co., Belmont, Nevada. From 3 to 4 tons of a silicious silver-bearing concentrate is produced per day. The concentrate is settled, drained, and dried on floors to 5% moisture. It is then sacked and hauled to the railroad, where it is loaded into box-cars. The cost per ton for draining and drying is $2.20 and $1.22 for sacking. This method is not satisfactory and the present management is arranging for a totally different method of handling.

3. Name not given. About 45 tons of 60% zinc concentrate, all −65 mesh, is handled daily. The froth, with a water ratio of 6:1, is run through a 6-in. pipe into bins. Clear water is drawn off between the settled concentrate and the froth. The bins are of concrete, and each holds 20 tons. They are lined with steam-coils. The dried concentrate, containing about 12% moisture, is dropped through doors in the bottom of the bins into wheelbarrows and is loaded into unlined box-cars. The cost is 40c. per ton for drying and 10c. per ton for loading. Coal costs $2 per ton. The condensation from the pipes is returned to the boilers. A filter will be desirable if a larger tonnage is to be handled.

4. M. W. Atwater, Basin, Montana. About 20 tons of zinc concentrate is produced daily. All of it is −80 mesh and 70% is −150 mesh. The froth, with a water ratio of 2:1, is run into one of four bins, each 10 by 10 ft. and 13 ft. high. The overflow, carrying a small proportion of the concentrate, passes into the next bin. When a bin is filled, the upper three feet is discharged into the overflow-bin. The concentrate is then shoveled through the bin-doors directly into box-cars lined with muslin. Two men can load 80 dry tons in 8 hours. The same men prepare the box-cars for loading and attend to the filling of the bins. The concentrate contains from 12 to 13% moisture when loaded, but this drops to 10 or 12% by the time the smelter is reached. As much as 700 tons of concentrate has been handled in the four bins in 30 days. The method is satisfactory, but it is necessary to have deep bins and ample bin-space. Cost of loading is 10c. per ton. The lining of the box-cars costs $2 each.

5. Atlas Mining & Milling Co., Sneffles, Colorado. The concentrate assays 10% silica, 20% iron, 12% zinc, 17% lead, 60 oz. silver, and 0.2 oz. gold. Fifteen tons is produced daily. The froth is treated on tables, and the concentrate sent to 50-ton collecting-tanks, the overflow from which is returned to the mill-circuit. From the tanks the concentrate is shoveled into small cars and trammed to an inclined chute 20 in. wide, 18 in. deep, and 90 ft. long, having three steam-pipes along the bottom. The chute discharges into a bin where the concentrate is sacked. It is then hauled to the railroad and shipped in box-cars lined with paper.

6. Mears & Wilfley, Silverton, Colorado. The 10 tons of concentrate made daily is mostly chalcopyrite, and ranges from 80 to 150-mesh. The froth is run into settling-tanks from which two drag-belts, 15 ft. long and 3 ft. wide, requiring ½ hp., pull the concentrate into a bin, from which it is loaded into canvas-lined box-cars by means of wheelbarrows. The concentrate runs 20% moisture when loaded, but only 13% by the time the smelter is reached. The canvas linings are sent back by return-freight. Linings show no wear after six months' use. Cost of handling is about 35c. per ton.

7. Flotation at Mt. Morgan.[1] The ore contains gold, copper pyrite, iron pyrite, and about 70% silica. At the 100-ton testing-plant of this company, the flotation-concentrate was first run into round vats 20 ft. in diameter, 10 ft. deep, and constructed with filter-bottoms. These proved unsatisfactory, as the wet slime kept to the outside and did not drain well. This difficulty was finally overcome by using a number of rectangular tanks, 9 ft. 10 in. by 10 ft. 9 in. and 3 ft. deep, with cocoa matting on a sand-filter bottom. The froth was run through the tanks in series, three or four always being in operation, and each filled with concentrate. The tanks drained to 7 or 8% moisture in 24 hours and the water was perfectly clear.

8. Britannia Mining & Smelting Co.[2] The concentrate, assaying 14% copper, 26.8% iron, and 20.8% silica, is taken from the flotation-machines by a drag-elevator that delivers it to the shipment-bins, where the moisture is reduced from 20 to 8% by draining. The Tacoma smelter draws the line at 10% moisture. The overflow from the bins goes to tanks, from which the sediment is delivered to the flotation-machines, while the overflow goes to Dorr thickeners. The thickeners give an overflow that goes to waste and a spigot product that is treated in the flotation-machines.

At a mill producing 13 tons of concentrate, assaying 5% lead, 5% copper, 28% iron, 18% silica, with some gold and silver, the froth is settled and dried in wooden tanks having steam-coils on the bottom. The concentrate is then shoveled into box-cars that have been lined with paper. Cost is about 18c. for drying, and 23c. for loading, or a total of 41c. per ton. The tanks do not give sufficient settling-area, and the costs are considered high.

At another plant, both a zinc and a lead concentrate are made. The total of concentrates produced is from 3 to 4 tons. The concentrate is settled in shallow tanks, 16 in. and 30 in. deep, the water being decanted. Steam is

[1] W. Shellshear, Aust. Inst. M. E., June, 1916.

[2] T. A. Rickard, M. & S. P., November 11, 1916.

then turned into pipes on the floor of the tanks. When the moisture is reduced to 11%, the concentrate is shoveled into box-cars lined with resin-sized building paper. The tanks are housed over. Some are provided with fan-induced draft for drawing off the water-vapor and the rest have natural draft. The former are the more satisfactory. The cost of loading is 21c. per ton.

A plant making 24 tons of lead concentrate per day uses a Dorr thickener to remove most of the water from the froth. The concentrate is then dried to the desired point in tanks 16 in. deep with steam-pipes along the bottom and the sides. Steam-pressure is 75 lb. per sq. in. The concentrate is loaded into unlined box-cars. Cost of treating is $1.15 per ton. The method is not satisfactory, and a filter will soon be installed. This use of steam for reducing the moisture-content of flotation-concentrate is expensive.

In the case of a plant producing 10 tons of concentrate per day, part of which is a 50% zinc product and the rest a 65% lead product, this material is settled in flat-bottom tanks, the water is then decanted, and the concentrate shoveled onto draining-platforms, from which it is loaded into box-cars lined with felt. The zinc concentrate contains 20% moisture, and the lead concentrate 15% moisture. Cost of treatment is about 20c. per ton. This method is only a temporary expedient; thickeners and filter will soon be installed. Even though it could be done easily, it would not be desirable to dry the concentrate to the point of dusting.

It is said that at the Miami mill, the concentrate from both the flotation-machines and the tables is run into round steel tanks having filter-bottoms, and with a central opening in the tank-bottom. A vacuum-pump accelerates the draining. When drained, a plug is removed and the concentrate is shoveled onto a belt-conveyor passing beneath the tanks. This conveyor discharges onto another or cross-conveyor that loads directly into box-cars.

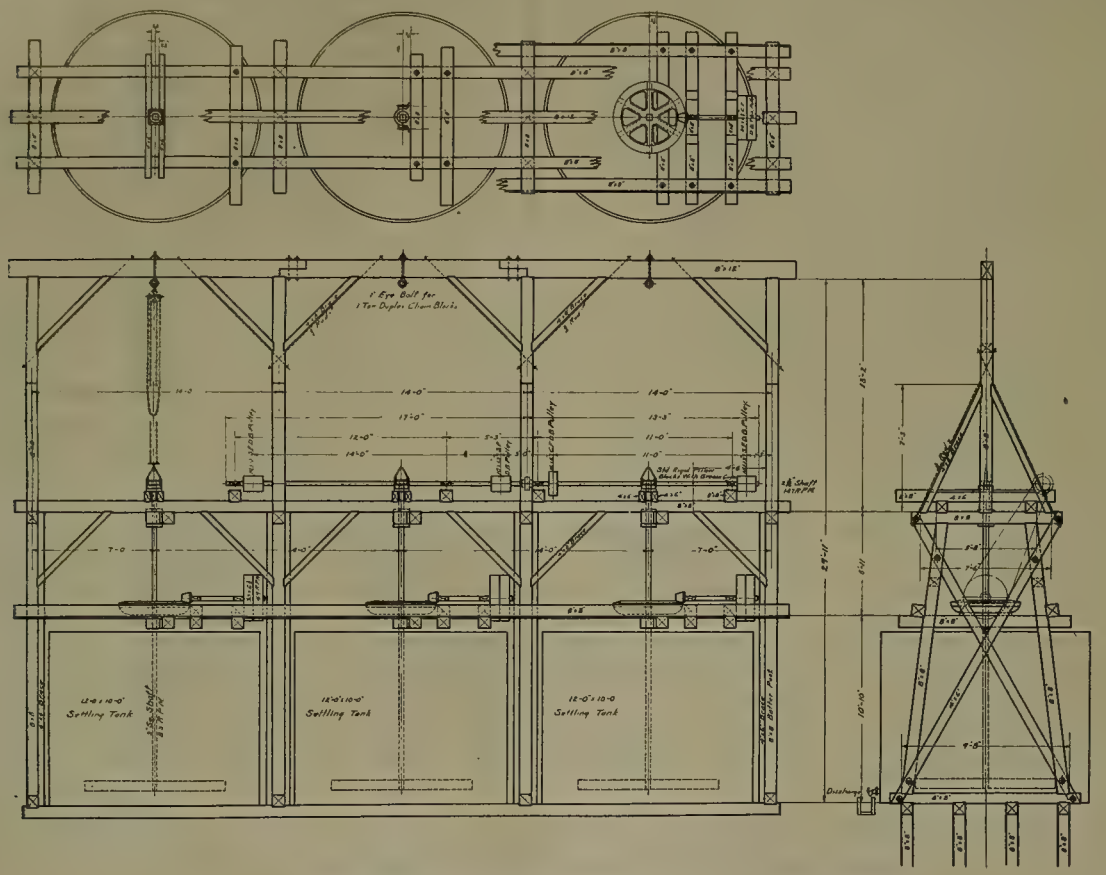


FIG. 1. AGITATORS FOR 12 BY 10-FT. TANKS, 50-TON ZINC PLANT MAGMA COPPER CO.

The most common method of dewatering flotation concentrate is by the use of thickeners and filters. Though this makes an expensive equipment, it gives a rapid and a fairly positive control over the moisture-content of the finished product. There is some accumulation of froth at the top of the thickeners. This is difficult to handle and contaminates the overflow from the tanks. Unique testimony to the apparent solidity of this accumulation is found at one mill where 'near-tragedies' are occasionally enacted because usual canine perspicacity fails to deter inquisitive dogs from attempting to take short cuts across the thickeners. Sprays are sometimes used in an attempt to break up this froth and baffle-boards may be employed, either around the edge of the tanks to protect the over-

flow, or at the centre and extending below the surface of the water in the tank. In the latter case, the incoming froth discharges into the space within the boards, and is broken up in passing out into the rest of the tank. The Consolidated Arizona Copper Co., at Humboldt, Arizona, has found it profitable to send all the flotation-tailing to thickeners, skim off the froth, and add it to the regular output.

The filters used are generally of the vacuum type, such as the Oliver and Portland, although the Kelly press, a pressure type, has been installed in some mills. The pressure-filter has the advantage that it can reduce the moisture in the concentrate to a very low figure, but it has been considered intermittent in action, costly to operate, and requires close attendance. However, a company that produces a large daily tonnage of concentrate has recently decided to install Kelly filters. These presses, of improved design, were adopted after a competitive test with a filter of the vacuum type. The vacuum-filter has no competitor when treating a concentrate that makes a thick cake and filters easily, but, when the concentrate is exceedingly fine and retains water tenaciously, the capacity of the filter becomes so reduced and the percentage of moisture left in the cake is so high that a filter of the Kelly type is to be preferred. A slight increase in total cost of operation (cost for labor is little, if any, greater than for the vacuum filter) is more than off-set by the reduced moisture in the product. The positive action of the Kelly press enables it to handle material that cannot be satisfactorily treated on a filter of the vacuum type.

In order to give sufficient capacity together with a low proportion of moisture in the cake, the vacuum-filter must have a feed that is at least 50% solid. At one mill the moisture in the material going to the filter must be held at the low figure of 35% in order to get satisfactory results. Heating the pulp in the filter-tank to about 100° F. or adding slaked lime will often increase the capacity of the filter. At the Inspiration mill Dr. Gahl has plotted the percentage of silica in the concentrate along with the moisture content of the filter-cake. A change in the former due to variations in the ore, or in the operation of the plant, is followed by a closely corresponding change in the latter. This suggests that the percentage of silica present has a marked effect on the dewatering action of the filter. It would be interesting to know whether this holds true in other plants and with different kinds of concentrate.

In a recent bulletin of the American Institute of Mining Engineers, J. M. Callow discusses the continuous thickening of feed for vacuum-filters. He states: "Our experience has not been satisfactory with the continuous plan, and it is for this reason that in all our recent plants, we have been installing the intermittent system. Until shown to the contrary, we think that this offers the best solution, in that with it you have complete control of the necessary density for the filters, there is no danger from losses in the overflow, and the froth which accumulates during the filling of the tank is completely disposed of at each cycle of the operation, and, therefore, cannot accumulate. The agitator for stirring the contents of the tank during the discharge period is copied from those used at the Goldfield Consolidated mill. It consists of arms secured to a square revolving shaft, suspended by a chain-block, and passing through a square hole in the driving-gear. It is simple, inexpensive, and gives no trouble whatever. It is illustrated in the accompanying figure. The thickened pulp may be drawn off from a central-bottom discharge. More recent practice is to draw off through a valve or molasses gate on the side of the tank, or better still, with a diaphragm-pump." Fig. 1 shows an installation for a 60-ton zinc plant.

The following examples illustrate the practice of filtering flotation concentrate.

1. Montezuma Mines & Milling Co., Montezuma, Colrado. This plant is producing daily 10 tons of concentrate that assays 42% zinc and 9% iron. The froth is sent to tables and the table-concentrate is filtered. The cake contains only 3% moisture.

2. Portland Gold Mining Co., Victor, Colorado. From 13 to 15 tons of concentrate, assaying 55 to 70% silica and 2 oz. gold, is made daily. The froth goes to Dorr thickeners and Portland filters. The moisture in the filter-cake is 30%. The concentrate is loaded by hand into tight-bottom box-cars. Cost of dewatering and loading is 50c. per ton. The results are not considered satisfactory.

3. Name omitted. Daily production is 10 tons of concentrate, assaying 40% zinc, 7% silica, 14% iron, 30% sulphur, 7% lead, with a little gold, silver, and copper. This is dewatered in Portland filters to 14% moisture, and loaded by hand into unlined box-cars. The cost for dewatering and loading is 15c. per ton.

4. St. Joseph Lead Co., Bonne Terre, Missouri. Forty tons of concentrate is handled per day. The analysis is 50% lead, 2% zinc, 9% lime, 4% iron and 6% insoluble. The froth, containing 90% moisture, goes to a 38 by 6 ft. Dorr thickener, which gives a spigot-product of 35% moisture. This pulp is sent to one 11 ft. 6 in. by 12 ft. Oliver filter, and the cake, containing 14% moisture, is loaded into gondola cars by means of a rubber-belt conveyor. A Root vacuum-pump, requiring 29½ hp. is used for the filter. The operation of the filter itself required 1½ hp. Cost for dewatering is 26c., for loading 2c. and for maintenance 6c., making a total of 34c. per ton.

5. Engels Copper Mining Co., Taylorsville, California. Between 30 and 40 tons of concentrate is produced in 16 hours. The assay is 35% copper and 30% insoluble. The froth is elevated to two settling-tanks having cone-shaped bottoms. The thickened concentrate then goes to an 8 by 8-ft. Oliver filter, which gives a cake containing 12% moisture. Steam is used to heat the pulp in the filter-tank. The filter-product is sacked and carried 1½ miles by a tram to auto-trucks, which, in turn, carry the concentrate to the railroad 30 miles away. The cost for dewatering and filtering is $1.50 per ton.

6. Bunker Hill & Sullivan Co., Kellogg, Idaho. An-

alysis of concentrate is 45.9% lead, 6.6% zinc, 13.2% sulphur, 10.4% insoluble, 9.8% iron, 26.6 oz. silver with a little copper and manganese. Twenty tons is produced per day, all of it – 200 mesh. A 40 by 12-ft. Dorr thickener and a 6 by 8-ft. Oliver filter are used for dewatering. The filtered concentrate contains 11% moisture. It is loaded into box-cars. The cost is 7c. for dewatering and 15c. for loading, making a total of 22c. per dry ton. It is essential that the feed to the filter be as thick as possible, about 35% moisture being a satisfactory figure. It has been found that wiping the oily film that forms on the filter-cake, with a rawhide beater, reduces the moisture nearly one-half.

7. Detroit Copper Mining Co., Morenci, Arizona. All flotation concentrate goes to one Dorr thickener. A 6 by 8-ft. Oliver filter takes as much of the thickened product as it can handle, together with the froth from the top of the thickener, which is removed by paddle-wheels. The slime-overflow from the thickener is sent to a settling-tank, and the spigot-product is shipped as flotation slime. An analysis of a composite sample of the filter-product and slime is 20.32% copper, 22.3% silica, 13.2% iron, 12.6% alumina, 1.4% lime, 1% magnesia, and 19.8% sulphur. The moisture in the filtered concentrate is 34.6%, and the slime carries 80.6% moisture, which necessitates its being shipped in tank-cars. The equipment is inadequate, and a larger plant is required to give satisfactory results.

8. Consolidated Nevada-Utah Corporation, Pioche, Nevada. About half of the total tonnage, 18 tons of concentrate per day, is thickened and filtered. It assays 42% zinc, 10% iron, 1% lead, and 11% insoluble. The flotation concentrate is very slimy and is mixed with the fine concentrate from the tables in order to obtain a product that can be filtered satisfactorily. The coarse concentrate from the roughing-tables is not filtered. Three 16-ft. agitators are used for thickening. One is running and one is filling while the third is being decanted. Each requires 5 hp. The 4 by 8-ft. Portland filter reduces the moisture to between 9 and 10% and consumes 1 hp. for operation. The concentrate is shipped in box-cars with a 12-in. board nailed across the door.

9. Old Dominion Copper Mining & Smelting Co., Globe, Arizona. Of the 36 dry tons of concentrate handled per day, fully 91% is – 200 mesh. An analysis gives 18% copper, 24% iron, 27% sulphur, and 22% insoluble. The froth, containing 8% solid, is pumped by a 3-in. centrifugal pump to a 10 by 28-ft. Dorr thickener, which gives a spigot-product of about 57% solid. This goes to an 8 by 11.5-ft. Oliver filter. The filter-cake contains 19% moisture. The filter discharges into a bin from which the concentrate is loaded into cars by means of wheelbarrows. The power consumption of thickener and filter is 1.24 kw. per hour. The filter operates at a 21-in. vacuum and 18 lb. for blowing-pressure. Cost is 1.6c. for dewatering and filter-power, 8c. for repairs to filter and renewal of canvas, and 21c. for loading concentrate, making a total of 30.6c. per ton. The comparatively high cost of loading is due to the necessity of loading into box-cars, which makes it impossible to use a belt-conveyor. Trouble is experienced from the accumulation of froth in the thickener. This robs the thickener of settling and thickening capacity. Sprays of water break up some of the froth but do not prevent a gradual accumulation.

10. Utah Leasing Co., Newhouse, Utah. The froth goes to a 22 by 10-ft. Dorr thickener and then to an 8 by 6-ft. Oliver filter, which gives a product containing 20 to 21% moisture. Great difficulty is experienced in settling and filtering the fine slime. Sodium silicate, soda-ash, and lime have been tried, but without marked results. Allowing 24 hours or more, of undisturbed settling in tanks seemed to be of little avail. Fifteen tons of concentrate is produced daily. It assays 15 to 16% copper, 33 to 36% silica, and 20 to 22% iron.

11. Gold Hunter Mining & Smelting Co., Mullan, Idaho. A screen analysis of the 30 tons of concentrate produced per day shows the following results: + 100 mesh, 0.2%; + 150 mesh, 1.8%; + 200 mesh, 6.4%; and – 200 mesh, 91.6%. It is a lead concentrate with about 16% silica. The froth is thickened to more than 50% solid in a 30 by 5-ft. Dorr thickener. Froth, running 60% solid, is mechanically skimmed at the top of the tank and unites with the spigot-product, going to an 8 by 6-ft. Oliver filter. A vacuum of from 24 to 25 in. is maintained by a wet-vacuum pump. A receiver with a barometric leg is used for the filtrate, which is clean but is run to settling-tanks. Oakdale No. 3 twill is used for the filter-cover. It lasts six months. The agitator is run at 30 r.p.m., but the air-lifts are not used. The emergency air-agitators are used once daily. The canvas is blown from one to three times per day with compressed air under 20 lb. pressure. Occasionally the canvas is steamed, using a 1-in. pipe perforated every inch with $\frac{1}{16}$-in. holes. Steam-pressure is 60 lb. per square inch. A scraper is mounted on a flat rigid casting that holds it just off the wires. The dried product drops into a bin, from which it is loaded into unlined box-cars by means of wheelbarrows. The concentrate contains 10% moisture. The overflow from the thickener is generally clean, but, at times, a little froth escapes. The overflow goes to settling-tanks and ponds. The cost is $4\frac{1}{3}$c. for dewatering, of which $3\frac{1}{3}$c. is for power and the rest is for repairs and labor. Loading cost 14c. per ton, being based on a wage of $4.50 for 8 hours. The filtered concentrate takes up more space and this adds to the cost, as it has to be shoveled back into cars.

12. Anaconda Copper Mining Co., Anaconda, Montana. From 1800 to 1900 tons of wet concentrate is produced per day. This is about 148 tons per filter-day. The screen analysis shows: + 48 mesh, 0.19%; – 48 and + 200 mesh, 29.7%; – 200 and + 300 mesh, 11.91%; – 300 mesh, 57.18%. The chemical analysis shows 9% copper, 28% silica, 25% iron oxide, 10% alumina, and 27% sulphur. Twenty-one 50 by 12-ft. Dorr thickeners are used. The thickeners for the slime-concentrate require 15 minutes for a revolution and consume 0.6 hp.

each. Those for the sand-concentrate revolve once in 9 minutes and consume 1.5 hp. each. The thirteen 11½ by 12-ft. Oliver filters require 1 hp. each for operation, 25 hp. each for wet vacuum, and 15 hp. each for dry vacuum. The filter-feed is thickened to 50% solid and the cake runs 15% moisture. The pulp is heated to 100° F. in the filter-tank. The filtered concentrate is taken directly to the roasters on an 18-in. belt-conveyor, which requires 25 hp. for its operation. The method is satisfactory. The belt-conveyor handles the material without difficulty. The froth, containing from 18 to 20% solid, is delivered to a baffle-box at the centre of each Dorr thickener. The box is about 5 ft. square and extends down to within a few inches of the rakes. Surrounding this is another baffle about 15 ft. square and extending about 18 in. below the surface of the water. The baffles catch a large part of the froth, which is there broken up by a spray of water. The overflow, containing a small amount of fine material that will not settle, is run to a slime-pond.

13. Calaveras Copper Co., Copperopolis, California.[3] The concentrate contains 14.4% copper, 29.5% iron, and 14.9% insoluble. When the remodeling of the plant is completed about 50 tons of concentrate will be produced daily. At present the output is 25 to 28 tons. The froth is thickened to 60% solid in a 22 by 10-ft. Dorr thickener and the moisture is reduced to 13% by means of an 8-ft. Oliver filter. In the new plant, it is planned to convey the thickened product to the filters through a 5-in. pipe, which will contain a 1-in. steam-pipe. This will heat the pulp without diluting it with the condensed steam.

14. Braden Copper Co., Chile. Both the table and flotation concentrate are run into concrete settling-tanks at the bottom of the mill. There are eight tanks in all, and four are used together alternately. The settled table and coarse flotation concentrate is loaded by a grab-bucket into cars. The tank-overflow, having a water-ratio of 10 or 20:1, goes to Dorr thickeners and the thickened product (water ratio of 1:1), is sent to two Kelly and four Oliver filters, only four of which are in operation at the same time. About 50 tons of solid per day is recovered in this manner. The fineness of the material, 98% of which is −200 mesh, results in low filter-capacity. At this plant supplies constitute 60.4% of the total direct milling-cost. Concentrate-handling makes up 8.33% of the total labor and 1.14% of the total supplies. Filtering concentrate makes up 5.46% of the total labor and 2.61% of the total supplies. About 50 tons is handled per day, of which 98% is −200 mesh.

15. Inspiration Consolidated Copper Co., Miami, Arizona. Five 60-ft. and three 80-ft. Dorr thickeners are used for handling 651 dry tons per day of mixed table and flotation concentrate. The latter amounts to 75% of total concentrate by weight and carries 90% of the copper. This gives 44.8 sq. ft. settling-area per ton of concentrate. The thickened product, having a water ratio of 1.65:1, passes through tunnels to two bucket-elevators, which deliver it to six 11 ft. 6 in. by 12-ft. Oliver filters. The filter-cake contains approximately 17% moisture. In attempting to reduce the moisture in the cake, the pulp in the filter-tanks was heated by steam. This increased the capacity of the filters, but did not affect the moisture in the cake. Adding slaked lime gave the same result. Lime is now used to increase the capacity of the filters. A double ring of high boards is used to prevent the contamination of the thickener-overflow by the froth accumulated on top. A record was kept of the portion of silica in the concentrate and the moisture in the filter-cake. The results are shown in the accompanying chart, Fig. 2 (Sept. 1916 Bull., A. I. M. E.), and would seem to indicate that the amount of moisture remaining in the cake depends upon the silica present in the concentrate. An 18-in. belt-conveyor running at a speed of 150 ft. per min., carries the concentrate to a steel loading-bin, directly above the railroad track. At the head pulley a rubber scraper is used to assist in removing the concentrate from the belt-conveyor. The bin is round with a cone-shaped bottom. Some difficulty is experienced in discharging the material from the bin. The total power consumption for thickening, elevating, filtering, and conveying is 5.1 kw.-hr. per ton of concentrate. The cost for dewatering and loading is between 20 and 25c. per ton.

A certain plant, producing 15 tons of a 12% copper concentrate per day uses a Dorr thickener and a 4 by 8-ft. Oliver filter. The cake is shoveled into wagons. Cost for dewatering and loading is given as 50c. per ton. Another plant, making 35 tons of zinc-lead concentrate per day, delivers the froth to a bucket-elevator in order to break it up. It then goes, without dewatering, to an Oliver filter, which gives a cake containing 10% moisture. This is loaded into gondola cars lined with canvas. The cost is 10c. per ton.

A copper company, which produces from 15 to 18 tons of concentrate per day, assaying from 14 to 18% copper and 28 to 34% silica, thickens the froth in Callow cones and then sends it to an Oliver filter. The filter-cake drops down a chute lined with 1.5-in. steam-pipes into a bin, which is also lined with steam-pipes. The concentrate is then shoveled from the bin, and shipped in gondola cars patched with sacks and thin boards. In spite of the filtering and drying, the shipping-concentrate runs from 14 to 18% moisture. It is so wet and sticky that it requires a great deal of shoveling. Cost of loading is from 22 to 25c. per ton. The dewatering and drying cost is not known.

Smelting Flotation Concentrate. The concentrate generally comes to smelters so well established in methods of operation that their work is of a routine nature. If this material is put through the regular smelting process, it has been found that the physical condition of the concentrate is such as to require certain modifications in the usual methods of operation.

The actual smelting of a flotation product is quite similar to the smelting of any other concentrate. The objections to it are of a physical rather than of a chem-

[3]H. R. Robbins, M. & S. P., November 25, 1916.

ical nature, but they are enough to cause many smelters to impose a penalty of $1 per ton. If the concentrate arrives at the smelter in a wet and sticky condition, it is difficult and expensive to unload. A large moisture-content means extra fuel-consumption in driers and roasters, and in furnaces, when charged directly into them. The great fineness of the material causes a heavy loss from dusting. This is especially true where it is necessary to smelt in blast-furnaces. Briquetting should reduce this loss, but it is often difficult to produce satisfactory briquettes. Unless it can be mixed with

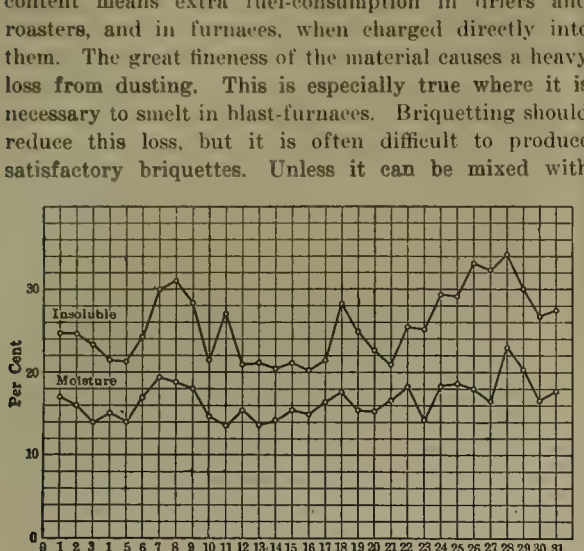


FIG. 2. CHART SHOWING SILICA IN CONCENTRATE AND MOISTURE IN FILTER-CAKE.

a large proportion of coarse material, flotation concentrate is hard to sinter. It chokes the grates, interferes with the draft, and reduces the capacity of the sintering machines. In some cases it may be necessary to pre-roast before a successful sinter can be produced. During the roasting process, there is often a marked tendency toward agglomeration or 'balling up,' and lumps are formed that roast on the outside only. Fig. 3 shows two lumps (natural size) of zinc concentrate that passed through the roaster, but came out with unaltered cores. Often troublesome accretions are formed in the roasters. At one plant it was found that a preliminary drying of the concentrate before roasting prevented 'balling.' However, drying usually makes the material lumpy and hard to feed. Where a large amount of flotation concentrate is roasted, special apron-feeders must be provided to handle this material.

The roasted product is of such a light and fluffy nature that it must be handled with great care to keep down the loss from dusting. At one plant, the cars are loaded in a tunnel connected to a dust-chamber and stack. Should a sufficiently large amount of dust be produced, it would pay to add a Cottrell tube-system. At another copper smelter, the side walls of the reverberatory furnaces have slots cut through them just above the slag-line. Inclined iron plates are fastened to the outside of the walls so that the charge can be shoveled onto them and work slowly down into the furnace as the smelting proceeds. This method of gently presenting the charge to the heat at a point where the draft is weakest causes a minimum formation of dust. It is far less than if centre-charging is used.

The foregoing discussion concerns lead and copper smelting, but zinc smelters, as well, have their troubles when treating flotation concentrate. At one plant, the unloading from cars is done by shoveling or by a grab-bucket. The material is then dried in a rotary drier and roasted in muffle-kilns. Because of its fineness, it is considered more difficult to treat than other zinc concentrate. At a second plant, all the unloading is done by shoveling, but it is considered an unsatisfactory method. At a third plant, shoveling is considered expensive, though it is acceptable in other regards. The concentrate is roasted in open-hearth furnaces fired with natural gas. Very little trouble is experienced in roasting. No difficulty is found in smelting, but the dust-loss is higher than for coarser material. At a fourth plant, flotation concentrate makes trouble all through the smelting process. Unloading is done by shoveling into wheelbarrows. The material is frozen in winter and is hard to handle. It is roasted in reverberatory furnaces to 1% sulphur or less (cost of roasting is about $1.70 per ton). The coarse concentrate is first dried to about 4% moisture, but the fine concentrate is not dried. The difficulties found in roasting are high dust-loss, the forming of accretions in the roasters, and the fusing of the fine concentrate. Smelting is done in the usual gas-fired distillation-furnaces. The fine material is more sub-

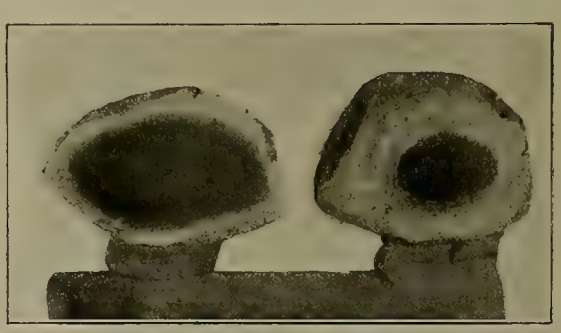


FIG. 3. LUMPS OF INCOMPLETELY ROASTED ZINC CONCENTRATE SHOWING UNALTERED CORES OF SULPHIDE.

ject to loss through overheating. It slags more easily with consequent loss of retorts. The charge is more likely to cake in the charge-cars, if too wet, and to blow out of the retorts, if too dry. The very fine flotation concentrate is difficult to roast and smelt.

One smelter superintendent forcibly summarizes the situation in the following brief sentence. "Flotation concentrate is considered a damned nuisance."

Examples of smelting practice are given below.

1. Consolidated Mining & Smelting Co. of Canada, Trail, B. C. The amount of flotation concentrate smelted is too small to afford reliable data. It is charged directly into blast-furnaces, so that the dust-loss probably is serious. A briquetting plant is being installed.

2. Omaha Plant, American Smelting & Refining Co., Nebraska. The copper concentrate, used incidentally to supply sulphur to the charge, is briquetted with 7% lime, and, after drying for 72 hours, is charged into the

blast-furnaces. This material, even after briquetting, produces considerable flue-dust.

3. U. S. Smelting Co., Midvale, Utah. The concentrate is shoveled from the cars and is briquetted with flue or bag-house dust, heavy with lime that had been introduced for the purpose of neutralization. The cost is about $1 per ton. The sintering in Dwight-Lloyd machines is not good, due to a poor mixing. The product is smelted in lead blast-furnaces. Flotation concentrate is considered a great nuisance.

4. Garfield Smelting Co., Garfield, Utah. The flotation concentrate is mixed with table and vanner products. It is then bedded with fluxing ores and later fed to McDougall and Herreshoff roasters. While the quantity of flotation concentrate treated is too small to cause any serious difficulty or to require special treatment, close observation shows that it has a tendency to form lumps that do not break up easily in the roasters. In fact, some lumps roast only on the outside. A large increase in the amount of flotation concentrate handled would probably necessitate a special feeding device.

5. Selby Smelting Co., California. The flotation concentrate is unloaded by shoveling and is spread out to dry. Cost for spreading is about 30c. per ton. It is then sintered and smelted in lead blast-furnaces. No trouble is experienced, other than the production of a large amount of flue-dust.

6. Anaconda Copper Mining Co., Montana. About 20% of fine table and jig concentrate is mixed with the flotation product. This is delivered to Wedge roasters by belt-conveyors. Each furnace-bin holds 25 tons. A large steel apron-feeder is used for supplying the material to the furnace. The roasted product is extremely fine and difficult to handle. It is loaded into covered cars in a tunnel that is entirely closed except for a stack at one end, which produces a slight draft. The amount of dust issuing from the stack is small. If sufficiently valuable, the dust could be recovered by a Cottrell precipitator. The smelting in coal-fired reverberatory furnaces presents no difficulties.

7. Murray Plant, American Smelting & Refining Co., Utah. The flotation concentrate arriving at this plant is wet and sticky, and bad to handle. It is mixed with sulphide ores and roasted or sintered and then smelted in lead blast-furnaces. It is considered to have an adverse effect on the smelting process. It chokes the roasters and tends to give a poorly-roasted product. The dust-loss is heavy. The fine powdery product is objectionable from a lead-smelting standpoint.

8. Ohio & Colorado Smelting & Refining Co. All flotation concentrate is either pre-roasted and sintered or sintered directly. The pre-roasting is done, after mixing with coarser material, in Godfrey and Wedge furnaces. The flue-dust and mechanical dust-loss is increased. Dwight-Lloyd machines are used for sintering. Even though coarser material is added, the capacity of the sintering-machines is decreased.

9. Bartlesville Zinc Co., Bartlesville, Oklahoma. The zinc concentrate from filter-presses is unloaded by shoveling. It must be dried in a machine of special design to avoid excessive dust-loss. It is then roasted in ordinary kilns. Allowance for excessive dust losses met with at every step in its treatment should be provided for when purchasing flotation concentrate.

10. Braden Copper Co., Chile.[4] The first flotation concentrate produced at the plant was so wet that it could not be briquetted, and so fine that it was hard to filter and dry. When charged directly into the blast-furnaces, the amount of coke required was increased from 12 to 16%. The drained concentrate from the bins contained 50% moisture and the filtered concentrate ran 30% moisture. After much experimenting, it was found that nodulizing in rotating kilns gave a product that was a first-class smelting material.

11. International Smelting Co., Miami, Arizona. The concentrate is unloaded from steel cars, having removable bottoms, onto belt-conveyors that deliver it to bedding-bins, where the necessary fluxes are added. The beds contain about 4000 tons, 80% of which is flotation concentrate, and are made in V-shaped steel bins that have removable-slat bottoms. Beginning at one end, the mixture is fed from an approximately vertical face onto a belt-conveyor, which discharges into Wedge roasters, used as driers only. The material is sticky and hard to handle. It is dried to about 14% mosture, and is then fed to oil-fired reverberatory furnaces. The difficulties in smelting are practically of a mechanical nature, due to the handling of this extremely fine charge, 50% of which is −200 mesh. The plant was designed for smelting flotation concentrate, and every precaution was taken to avoid dust-losses.

12. At Mt. Morgan, Queensland, Australia,[5] an ore containing about 2% copper and from $5 to $7 in gold is treated by flotation. Nearly 70% of the gold is free. It was found that by grinding the ore very fine, much of the gold was caught in the thick froth of the flotation-machine. The ore was ground to 80-mesh. There was no increase in the saving of copper, but the extra gold recovered paid for the cost of grinding. As long as only a small tonnage was treated, the concentrate was mixed with blast-furnace flue-dust, in the proportion of 1:3, and sintered in a Dwight-Lloyd machine with excellent results. But when the percentage of concentrate was increased, the sulphur content rose to such a figure that the machine did not give a good product, and its capacity was reduced, owing to the choking of the bed by fine concentrate. Pre-roasting followed by pot-roasting was then tried. An Edwards furnace was first used, but the roasted product was so fine that it could not be handled in the Dwight-Lloyd machine or in the pots. Tests made by pre-roasting in a Godfrey furnace and sintering in pots proved satisfactory, and such a plant was installed. It was found that the product from the Godfrey furnace was coarser than the concentrate, some agglomeration

[4]R. E. Douglass and B. T. Colley, *Eng. & Min. Jour.*, February 12, 1916.

[5]B. Magnus. 'Sintering Flotation Concentrates.' *Eng. & Min. Jour.*, June 10, 1916.

evidently taking place. A sketch of one of the sintering-pots is shown in the accompanying figure.

13. Tacoma Smelting Co., Tacoma, Washington. The flotation-concentrate arriving at this plant is unloaded from ships in tubs that are filled by hand-shoveling. Owing to the sticky character of the material, this work is disagreeable and costly. Roasting is done in Herreshoff furnaces, the upper floors of which are used for drying only. It is necessary to clean the roasters frequently. Reverberatory furnaces are used for smelting. Elaborate machinery must be used in order to keep dust-losses from becoming excessive.

14. Helena (Montana) plant of A. S. & R. Co. Unless

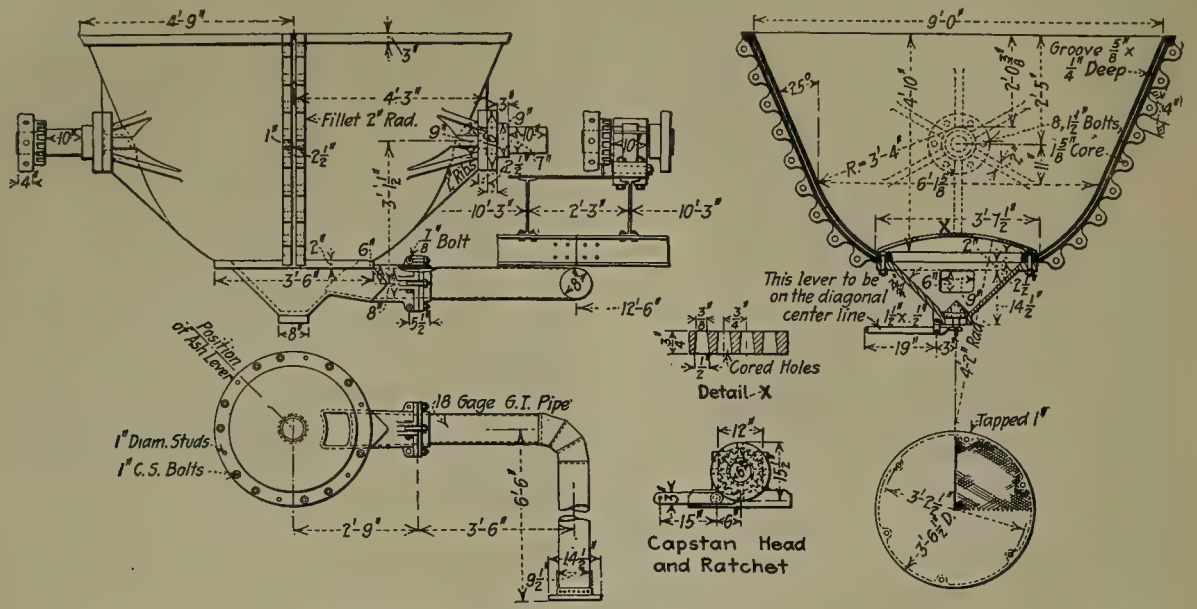


FIG. 4. SINTERING-POT USED AT MOUNT MORGAN.

filtering or drying has been done at the mill, the flotation-concentrate sent to this plant carries from 20 to 25% moisture. In summer this material has the consistence of liquid mud, and could almost be unloaded from cars by means of a pump. In practice, men wearing high rubber boots shovel the concentrate from the cars into bins. The cars can be washed out, but the material sticks to the sides of the bins, dries, and causes loss from dusting. In winter the concentrate will freeze solid in the car, and has to be thawed or else mined with gads and picks. The cost of unloading is then excessive. No particular difficulty is presented when the concentrate has been dried or filtered before shipping. The lead concentrate is first sintered in Dwight-Lloyd machines. From 10 to 15% of flotation-concentrate is mixed with miscellaneous sulphide ores, including a small quantity of matte and from 5 to 10% of crushed limestone. With this mixture a fairly good sinter can be obtained. This material is then transferred to H. & H. pots, where it is converted into a slagged and fairly porous product containing less than 2% sulphur. Smelting in lead blast-furnaces presents no difficulties. Owing to its extreme fineness, smelters must necessarily suffer considerable loss from dusting when handling flotation-concentrate. This loss is undoubtedly higher than in the case of ordinary ores or coarse concentrate; therefore it justifies a higher charge for treatment.

SUMMARY. The various methods of handling froth may be classified as follows:

1. Breaking by means of centrifugal pumps, bucket-elevators, jets, or on tables.

2. Dewatering in tanks, with or without filter-bottoms. Steam may be used to assist drying.

3. Dewatering in classifiers of the Ovoca and Akins type.

4. Continuous thickening, followed by filtering.

5. Intermittent thickening, followed by filtering.

The use of tanks for dewatering concentrate necessitates unloading by shoveling, unless the tonnage to be handled is sufficiently great to warrant the installation of a crane and grab-bucket. The cost of loading varies from 10c. per ton, where the concentrate can be shoveled directly into cars, to 25c. and more per ton, when wheelbarrows must be used. In case gondola cars are to be loaded, a belt-conveyor will reduce the cost to 2 or 3c. per ton. The employment of steam for drying can hardly be recommended, especially where pipes are placed in tanks. The concentrate should be spread out in a thin layer on a uniformly heated surface. In a tank the concentrate in contact with the steam-pipes is quickly dried, but the moisture is driven out only to condense in the main body of the concentrate, which dries very slowly. Such a method of dewatering is necessarily expensive. Filter-bottoms for tanks may be advisable where the concentrate drains fairly well, and, in such instances, the trouble from accumulated froth is eliminated. Where the water must be decanted from settled concentrate, the

decanting apparatus should be so designed that it can work in the clear water between the unbroken floating froth and the top of the settled concentrate.

Continuous thickening, followed by filtering is a method commonly employed, but the troubles arising from the accumulation of floating froth in the thickener and the difficulty, at times experienced, in getting a spigot product low enough in moisture for satisfactory filtering should be considered when making such an installation. One large company gives the cost of thickening in Dorr thickeners, dewatering on a continuous filter and loading by gravity at 65c. per ton. Another company states that thickening and filtering (continuous type) costs 10c. per ton. Intermittent thickening, followed by filtering, seems to offer the most positive control over the moisture in flotation concentrate. Filters of the pressure type will give good results on material that cannot be satisfactorily treated on vacuum-filters.

A preliminary treatment, before smelting, is nearly always given flotation concentrate. Such treatment would come under one of the following heads, although two or more may be combined:

1. Drying.
2. Briquetting.
3. Nodulizing.
4. Sintering.
5. Roasting.

The difficulties in the smelting of flotation concentrate are caused by the extreme fineness of this material. Briquetting should be a good method of preparing the concentrate for direct smelting in blast-furnaces, but it is not easy to make a strong briquette that will not break up and produce much flue-dust before it is smelted. Nodulizing gives an excellent smelting product, besides driving off some sulphur, but the loss in dust may be considerable. Roasting presents such troubles as the necessity of specially designed feeders for furnaces, the formation of accretions, and the non-roasting of the interior of lumps, heavy dust-losses, and the production of a light fluffy product that is not easy to handle. The cake from sintering or pre-roasting and sintering is quite suitable for feeding to blast-furnaces, but it is necessary to mix coarse material with the flotation concentrate in order to get a well-sintered product and to prevent too great a falling off in the capacity of the machines.

At the present time flotation concentrate, being a new and unusual material, is difficult to handle. Unless specially designed for the purpose, smelters cannot be expected to treat this product in the smooth manner of their regular work. However, metallurgists are keenly interested in solving the problems thus presented, and, as the tonnage of ores that are being concentrated by the flotation process increases, plants smelting only such concentrate will soon experience no serious hindrance to satisfactory operation.

SILVER has been selling during the last three months at prices not recorded since 1893.

Raw Material for Sodium Cyanide Manufacture

*The presence of cyanogen in coal-gas, or in the gases from a by-product coke-oven, is attributed to the breaking down of ammonia in contact with the hot coke or the highly heated walls of the retort. Although the amount of cyanogen obtainable depends on the quantity of nitrogen in the coal, there is a direct relation to the temperature of the coke and the walls of the coking-chamber, the higher temperatures favoring combination with the carbon to produce hydrocyanic acid, thus:

$$C + NH_3 = HCN + H_2$$

The original nitrogen content of the coal ranges from 1 to 2%. The removal of the cyanogen from the gases is possible only in the presence of ammonia, hence the extraction is accomplished previous to passing the gas through the ammonia-washers, but not until after the naphthalin has been absorbed by anthracene-oil, creosote-oil, or water-gas tar. The cyanide washer is an apparatus in which fresh iron sulphate enters at one end, meeting a current of the oven-gases. The H_2S in the gas first precipitates mono-sulphide of iron, which in turn reacts with the cyanogen and ammonia, forming ferro-cyanide of ammonia. The sludge liquors are treated in a still and neutralized with sulphuric acid. They then contain insoluble double ferro-cyanide of ammonia and iron, along with ammonium sulphate, ferrous sulphate, and free acid. This is filter-pressed, and the press-cake, or 'blue,' as it is called in the trade, is sold on the basis of its equivalent in potassium ferro-cyanide,

$$(K_4Fe(CN)_6.3H_2O),$$

and from this crude product is manufactured the sodium cyanide used in the metallurgy of gold.

POCKETS OF GOLD are not confined to any particular kind of rock. They have been found in limestone, in granite, in slate, in diabase, in andesite, in tuff, in quartz veins, in seams where there was apparently no vein at all. It is rather the existence of peculiar structural conditions that influences the deposition of gold in those masses called pockets, rather than the kind of rock. No two pocket-mines are exactly alike, nor do any two pockets occur under identical conditions. In the pocket-mines of California the gold is usually found at the intersection of two or more planes—veins, jointing planes, and small planes of fracture—most often where three such planes intersect.

DETONATORS were formerly made of mercury fulminate or of the fulminate mixed with potassium chlorate. At the present time detonators are often made of a mixture of mercury fulminate with picric acid, trinitrotoluol, or tetranitromethalamine. The initial detonation is said to be increased by this mixture, so that a cap containing 16% of the quantity of the fulminate formerly used possesses equal efficiency.

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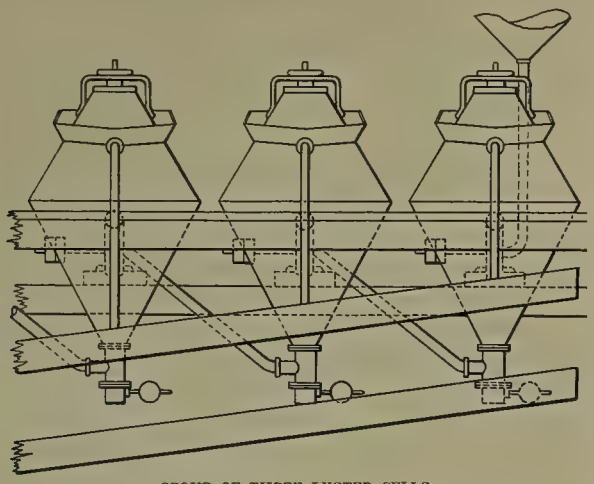
*Abstract from *The Chemical Engineer*.

Sulphur Di-Oxide as a Floatative Agent

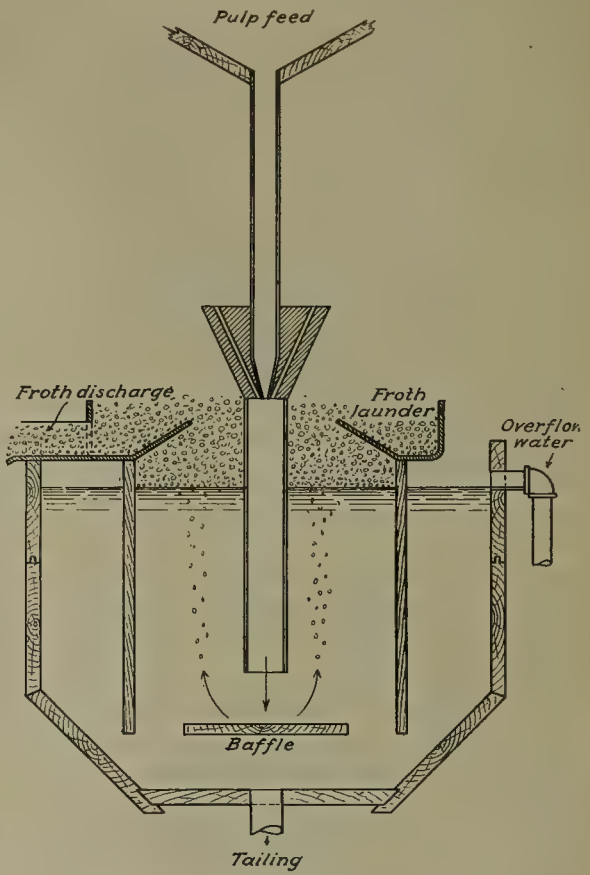
A unique development of the flotation method of concentration has recently been put into practice on a large scale at the Broken Hill Proprietary Company's mines in Australia. The object is to discriminate by selective flotation between the blende and the galena in the ore. At the present time it is being used in the treatment of the lead-zinc slime accumulated from previous gravity concentration that could not be successfully dealt with by the Delprat process. None of the more familiar floatative agents are employed. The Lyster type of cell is utilized, a number of cells being connected into a series, as shown in the accompanying cut. The American patent No. 1,203,372, issued to Fleury James Lyster of Broken Hill, New South Wales, and assigned to the Minerals Separation American Syndicate, Ltd., claims a process for



GROUP OF THREE LYSTER CELLS.

"subjecting ores to flotation separation by agitation with the frothing agent in the non-acid solution of the mineral acid salts of metals which form basic hydroxides, and thereby separating the lead sulphide from the zinc sulphide." Four additional patents were granted to Lyster, No. 1,203,373-4-5, for other improvements in flotation. These relate to the use, in one case, of a salt of a mineral acid having an alkaline reaction together with a small proportion of a frothing agent in the solution; for example, sodium carbonate is proposed in conjunction with a frothing agent for lifting out the fine galena from a mixture of lead and zinc sulphides in the ore. In another case he claims promotion of selective action by the introduction of a chloride, such as common salt, along with an alkaline hydrate, the selectivity being more pronounced by using an excess of the hydrate.

The sulphur-dioxide method, as now adapted at the Broken Hill plant, employs centrifugal pumps connected in the series, one taking the original feed-pulp, and one being interposed between each cell. The centrifugal pumps are peculiar in their construction, consisting of a disc-runner with lugs or blades on the sides operating between corresponding concentric rows of similar lugs or blades attached to the pump-shell. The object of the lugs is to disintegrate the lumpy tailing. Tapped into the suction-inlet of the pump is a pipe which is again branched a few inches above the point of union with the suction, the second branch leading from a sulphur-burner. The sulphur-fume is drawn in along with air which enters through the main branch of this pipe, the mixed gases being thus carried into the pump entrained in the pulp-feed. The pulp is delivered to the pump from an agitation-tank, which in turn is supplied by a tailing belt-conveyor, upon which is fed salt-cake in the proportion of 2 to 2½ lb. per ton of the tailing. Salt-



ELEMENTS OF SEAL-SHELLSHEAR FLOTATION CELL.

cake is the crude sodium sulphate produced in the manufacture of soda-ash. The charge in the agitator is heated to a temperature of 90° before being drawn to the centrifugal pump; thence it is forced through cell No. 1, from which a lead-froth concentrate is delivered. Thence the tailing passes through the second pump, also drawing in air and SO_2, but no more SO_2 is added beyond this point. By the time the solution has reached cell No. 5, the SO_2 has all been evolved from the pulp, and zinc concentrate begins to appear with the lead in the froth. The mixed concentrate from cell No. 5 is returned to the agitator, and once more traverses the first series of flotation-cells. The tailing from No. 5 is heated to a temperature of 120° by steam, and about 18 lb. of sul-

phuric acid per ton of pulp-solids is introduced. This pulp is circulated in the same manner as before through five cells, all those after No. 5 in this second series yielding zinc concentrate of a grade suitable for retorting.

It must be pointed out that in the sulphur-burner a considerable quantity of SO_3 is produced along with the SO_2, and that consequently the pulp in the first five cells contains a moderate amount of H_2SO_4. Further details regarding this process, which we understand is due to the inventive ability of Leslie Bradford, will be awaited with great interest. The successful selection of lead sulphide in the Bradford process is mainly the result of intense aeration, in combination with the effect of the sulphur di-oxide in retarding the flotation of the zinc sulphide until the lead is lifted. The use of the salt-cake is to increase the specific gravity of the liquor, the proper density of the medium being frequently a matter of great importance in flotation. The best recoveries from the Broken Hill ores have been accomplished with a solution having a density of approximately 1.05. The addition of the sulphuric acid is significant of local conditions. The Broken Hill ore contains on an average about 3.2% calcium carbonate, which is soft and tends to accumulate in the slime during the milling process. It is reasonable to assume, therefore, that considerable finely divided calcite is present in the slime treated by the Bradford method. The sulphuric acid would liberate carbon di-oxide from this. In the acid flotation process more than 6% of slime will seriously affect, and at times even will prevent, the recovery of the sulphides owing to the fact that most of the calcite is in a state of such minute subdivision that the gas evolved from reaction with the H_2SO_4 forms exceedingly small bubbles, which individually have a low lifting power, and are prevented from coalescing by the viscosity given to the medium by the suspended slime. The addition of the large volume of air in the method worked out by Bradford would overcome this difficulty, and the carbonic acid gas would materially aid the air in separating the zinc sulphide from the acidulated solution.

At the Sulphide Corporation, jigging of the 40-mesh galena is being superseded by flotation, using a Seal-Shellshear machine, the principle of which is shown in the accompanying outline drawing, which makes no attempt to indicate the actual mechanical details. The jet from the feed-boxes produces an exhaust, drawing air downward into the delivery-column below the perforated cast-iron jacket. The stream under pressure due to the head strikes the baffle, which produces, by reaction, sufficient agitation with the entrained air to develop froth that lifts the galena. A small quantity of eucalyptus oil is added to the pulp as a floatative agent. These cells are connected in series, and the tailing from cell No. 5 goes to a Hebbard machine, where the pulp is heated by steam jets to a temperature of 120°, with the addition of sulphuric acid and eucalyptus oil, thus effecting the flotation of the zinc-blende. This method of selective flotation is also said to yield excellent results. The earlier practice at the Sulphide Corporation was to jig at 5-mesh to recover the coarse lead sulphide, then to re-grind the jig tailing to 40-mesh, and concentrate on tables to obtain more of the galena, after which the total reject from the tables was treated by flotation, yielding a concentrate containing 12% lead. The zinc and lead in the flotation-concentrate were subsequently separated by tabling.

The Romance of Silver

*An interesting lecture on 'Silver: Its Romance and History' was given recently in London by Benjamin White, Fellow of the Economic Society, in aid of the Red Cross Funds. He traced the history of the metal from the earliest times. Referring to the output of silver, he said: "The production of the world amounted in 1914 to 211,000,000 oz., worth, say, £26,000,000, being six times the production in 1869. North America produced 170, South America 13, Europe 15, Asia 6, Australasia 4, and Africa 1 million. Almost nine-tenths of the silver comes from the Americas. It is an extraordinary circumstance that two-thirds of the world's production is absorbed by Asia. In the Middle Ages silver was derived from Great Britain, France, Austria, and Germany. The beautiful color called Saxony-blue was made from the cobalt mines of that country. Three subsequent great epochs may be noted: first, the Spanish discovery of the mineral wealth of Mexico and Peru about the year 1520. Stripped of the glamor of historians, it was a squalid story of massacre and slavery. Many galleons laden with treasure formed part of the Spanish Armada, and were wrecked upon the British coast; secondly, the discovery in 1859 of the Comstock Lode in Nevada. A rush of hardy miners ensued, and fresh finds were made. So much silver was yielded that, coincident with the discovery of the gold in California, bimetallism had to be abandoned, that is, the free coinage of both metals at a fixed ratio to each other had to be given up. The Anaconda mine, in Montana, is the largest producing mine today; its annual output being 9,000,000 oz.; thirdly, in 1904, as a new railway was being driven through part of Ontario, traces of silver were discovered in a railway cutting. Within a few years, from an area only 50 miles in diameter, 30,000,000 oz. of silver was mined in one year alone."

THE DANISH WEST INDIES, recently purchased by the United States for $25,000,000, were originally bought from France by Denmark in 1733 for a sum equal to $150,000. The islands are of great beauty and possessed of an almost ideal climate. The soil is extremely fertile, and well adapted for the culture of sugar cane. The only mineral prospects are on the island of St. John, where copper exists in a ferruginous zone that has received no attention hitherto. Deposits of a good grade of yellow ochre are found in the same zone. Limestone exists both on St. John and St. Croix, and is employed in the purification of the cane-juice in the sugar mills.

*_The Financial Times._

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

OATMAN, ARIZONA

ENLARGEMENT OF THE PLANT AT THE TOM REED.—UNITED EASTERN OUTPUT.

At the Nellie property in the Black Range part of the Oatman district the shaft has reached a depth of 500 ft. and as soon as a station and sump can be cut a cross-cut will be driven to the wide vein. On the 350-ft. level a drift along the hanging wall for a distance of 162 ft. disclosed a leached condition, the daily samples ranging from $2 to $3 up to $35 per ton. The shaft passed into the vein at 360 ft. The vein dips at 45° and, in sinking the shaft, passed through 26 ft. of solid quartz that averaged $9 per ton. It is the belief of those who have examined the Nellie that the 500-ft. level will prove to be the lower limit of leaching and may contain rich shoots of ore due to secondary enrichment.——Bullion to the value of $74,500 was shipped from the United Eastern on March 21, the result of 12 days' operation of the 200-ton mill. The mill is now treating in excess of 200 tons daily, and where the ore is soft the tonnage runs up around 225. The No. 2 shaft, through which the ore is hoisted, has lately been connected with the 665-ft. level and sinking will be resumed upon the arrival of an auxiliary hoist.——Five redwood tanks 40 ft. in diameter and 12 ft. high, completing the tankage for the new unit of the Tom Reed mill, have been constructed. Cement foundations for the tanks and crushing-equipment were completed some time ago and the machinery will all be installed within 30 days. Several Allis-Chalmers granulators will be installed, and the twenty 1050-lb. stamps, so long in use, will be discarded. The present output is 120 tons daily, of which 40 to 50 tons is supplied by the new Aztec orebody. The Aztec shaft is one mile from the mill and the ore for the present is transported by auto-truck. Later an aerial-tramway will be installed. The new mills will more than double the output, which for ten months has averaged about $43,000 per month.——The average of the east drift on the new 600-ft. level of the Big Jim for the first 70 ft. from the cross-cut was $18.14 per ton. Lately the ore has improved and face samples have run as high as $144 per ton. Superintendent Keating estimates the mine and mill costs not to exceed $5 per ton. As soon as the 600-ft. level is opened sufficiently mill-tests will be concluded and plans drawn for a mill. Marcy ball-mills, which have been successful at the United Eastern mill, will be installed at the Big Jim also.——The production for the first quarter at the United Eastern ends March 31, and there is much interest among operators in the forthcoming report, which it is assumed will be issued early in April. Oatman ores are ideal for cyaniding, and the United Eastern is known to have made a high extraction, probably around 98%.

GOODSPRINGS, NEVADA

HIGH-GRADE ORE SHIPMENTS.—JEAN SAMPLER COMPLETED.

At a depth of 20 ft. a winze from the new tunnel in the Platino mine has encountered a 24-in. shoot of high-grade copper ore. Manganese and iron also shows, and a small amount of gold and platinum is present. Superintendent Springer has increased the working force and expects to make a shipment soon.

The Lucky Maid Silver, Lead & Zinc Co. has been incorporated by Las Vegas, Nevada, people to operate a group of claims adjoining the Green Monster mine. It is planned to install equipment and drive a 200-ft. tunnel to intersect the orebody exposed near the surface. Thomas Clark is president; H. H. Johnson, secretary.

The output of the Yellow Pine property is again becoming normal, following two months of reduced output because of severe weather and bad road conditions. The company is ready to start shipments from the lease taken over last fall from Griffith & Tuck, and generally known as the Charlestown property. The main orebody is yielding ore running 45% zinc.

The Jean sampler has been completed and Manager J. B. Jensen expects to start the machinery at once. A temporary track will be constructed to facilitate ore shipments until the Salt Lake Railway builds the necessary sidings. Large quantities of ore are already in the bins, and many large producers are prepared to ship.

J. R. Newberry, of Riverside, California, has extended the lease of Huston Corneilson on the Tam O'Shanter another year. It is provided, however, that a hoist, blower, and other equipment must be installed within 30 days. Several shipments of silver-lead ore have been made recently.

Charles Kalters and J. Robinson have purchased the Joseph Conaway lease on the Singer, an important producer. The lease on the Annex claim has been acquired by H. W. Ball from Peter H. Nelson and Fred W. Schwanbeck.

MONTERREY, MEXICO

NO FURTHER EXTENSION OF TIME TO FOREIGN OWNERS TO BE GRANTED BY CARRANZA.

The de facto government of Mexico has refused to make any further extension of the time-limit for the resumption of operations on mining properties in Mexico and it is stated that the work of confiscating all delinquent properties will be proceeded with as rapidly as possible. The original decree requiring that there be a renewal of operations at idle mines fixed the time for the Government to take over these properties, at November 14, 1916. In response to petitions of many American and other mine-owners the date was extended to March 14, 1917. According to the provisions of a new decree recently issued by the Government on the subject, the mine-owners of this country are divided into three groups. The first embraces those whose properties are now being worked; the second, those who applied for an extension of time in which to renew operations, and the third, those who have entirely ignored the decree. Leniency will be shown the mine-owners who belong to the first and second groups, it is officially stated, provided they furnish the department of fomento, prior to April 1, a detailed statement of what efforts they have made to comply with the decree. Those who are embraced in the third group will receive little consideration unless they come forward at once with explanations that are deemed satisfactory to the Government. It is stated that most of the larger American mining concerns, particularly the American Smelting & Refining Co., are in good standing with the Government with respect to the efforts that have been and are being made to operate their respective properties in this country, but there are hundreds of small mine-owners who for one reason or another have been forced to abandon their holdings and have no means of complying with the Government's decree.

PACHUCA, MEXICO

THE SANTA GERTRUDIS COMPANY REPORT, LAST QUARTER OF 1916.

The general manager's report on the working operations of the mines for the quarter from October 1 to December 31, 1916, is as follows:

The mill during the above period crushed 33,243 dry short tons of ore.

Value of bullion produced	£60,967
Less working expenses (including development and shipping and selling)	57,631
Estimated profit at mines	£ 3,336

There were no expenditures for construction.

MINE DEVELOPMENT. A total of 2467 ft. of development was accomplished throughout the mine, of which 981 ft. was in payable ore, 718 ft. in vein below pay, and 768 ft. in country rock. During this period the countershaft was unwatered below the 21st level, the recovery of all equipment accomplished, and subsequently the shaft was again allowed to flood to the 20th level.

Two hundred feet of driving and cross-cutting was accomplished during this period, most of which was in country rock and none of which was in pay ore. All the work tended to confirm the earlier evidence that this vein breaks up into numerous small stringers, of no value, before reaching this level. No further development work will be done at this horizon, and the workings have been permitted to flood to the natural water-level, which is 30 ft. below the 4th level.

The hanging-wall orebody lying between the North and No. 8 veins, and already opened up on the 14th and 16th levels, has now been proved to extend to the 13th level. Cross-cut N 2058 sampled 6.59 dwt. gold and 43.4 oz. silver for a width of 6.9 ft. while the cross-cut S, at the same parallel sampled 3.39 dwt. gold and 17.5 oz. silver for a width of 8 ft. The limits of mineralization have not yet been reached. Development work throughout the mine has been considerably reduced to conform to the conditions of curtailed production.

The average milling rate for the period under review was 33% capacity. This low rate was due to a shortage of cyanide, which, as yet, has not been relieved. Milling operations were completely suspended for 36 days and were carried on at a reduced rate during the remainder of the period. All work, including mine development, which is not immediately necessary for the present reduced production, has been suspended, pending an improvement in conditions pertaining to cyanide delivery.

Increased cost of living is making itself felt here, as elsewhere, in a gradually increasing wage schedule. The present scale is fully 25% higher than that of 1912, which it has been customary to take as normal.

SUTTER CREEK, CALIFORNIA

THE OLD EUREKA SHAFT NOW CLEAR DOWN TO THE 1760-FT. LEVEL.—OLD MINE NEAR PLYMOUTH TO BE OPENED.

The working force at the Old Eureka mine has been increased gradually, under the management of T. Walter Beam, until it now totals about 60 men. The shaft has been cleared to a depth of 1760 ft., and as soon as the débris remaining in the bottom of the shaft has been removed, work will be started cleaning out the old drifts and re-timbering the mine for future development. With the equipment now installed, prompt results are anticipated. Considering the delay in receiving the electrical machinery and the necessity for using a single-reel hoist and small skip, good headway has been made in getting the water all out of the shaft. The large platform that is on a level with the new engine is in course of construction. This platform rests on the 32-ft. concrete piers at the collar of the shaft, and the low ground around the collar of the shaft will be filled-in with the waste hoisted from the mine, so that the main buildings will be on level ground and easily accessible by road from the county highway.

W. E. Darrow, president of the California Slimes Concentrating Co., recently has secured a lease, covering the privilege of working the tailing that will flow from the new Argonaut mill to the large Eastwood dam near Jackson, which option he has assigned to his company, that already is successfully operating tailing-plants at the Fremont and Bunker Hill mills. During the week, Mr. Darrow has been engaged in transferring the electrical machinery from the Poundstone mine, the East Eureka, east of Sutter Creek, to his new plant, which will doubtless be ready for operation soon after the Argonaut mill begins crushing. Darrow is the inventor of a gold-saving machine that is a model of its kind, and the stockholders in his company receive frequent and substantial dividends.

B. Levaggi, of the Levaggi Estate Co. of Plymouth, has started a number of men to work on the Monte de Oro mine, two miles north of Plymouth. There is a large outcrop of quartz on this claim, formed by the intersection of three well-defined veins. The north end of the claim was prospected during former work by a cross-cut tunnel 785 ft. long, giving 200 ft. of backs, and some work has also been done by means of open-cuts on the south end of the claim. There is a 10-stamp mill on the ground, which Levaggi expects soon to get into operation. Some rock of good grade is exposed and ready for mining.

C. E. Bunker, who for several years was superintendent at the Keystone mine in Amador City, has been appointed to fill the vacancy caused by the resignation of E. Hampton, as superintendent of the Bunker Hill.

Shaft repairs are in progress at the Plymouth Con. Mines at Plymouth, and during this work a number of employees have been laid off temporarily.

Another strike of pay-rock has recently been made at the Oneida mine, on the lowest level, and while the extent of the new orebody has not yet been determined, assays are said to range from $16 to $46 per ton. Further development work is being urged vigorously.

GOLDFIELD, NEVADA

GOLDFIELD CONSOLIDATED FLOTATION-PLANT.—CORE-DRILLING ON JUMBO.

The first unit of the Goldfield Consolidated flotation-plant has been in operation about ten days, and is treating ore from the Atlanta and Consolidated mines. A good extraction is reported. The Consolidated company is steadily increasing development work in the Laguna and the deeper levels of the Mohawk. Fourteen sets of lessees are also at work.

A suit against the Yellow Tiger Mining Co. for $18,800, attorney's fees, and costs of the action, has been brought in the district court by T. S. Ellis, of Denver, Colorado. It is stated that various notes for money were advanced the company by T. Finley Wyle, of Denver, said notes having been assigned to plaintiff, who also advanced various sums to the company. The Yellow Tiger mine has been idle several months, and a movement is under way for re-organization of the company.

Water is causing trouble at the Cracker Jack and Silver Pick properties. In the latter a heavy flow has been struck in the west workings, but the pumps are said to be handling it without serious difficulty. In the Cracker Jack the water has risen to above the 200-ft. level, drowning the pumps and stopping all work. Additional pumping equipment has been ordered by H. G. McMahon, the manager.

Five carloads of ore is shipped monthly from the Great Bend to Utah smelters, the ore averaging around $40 per ton, all of which is from the 260-ft. level, where the vein is 4 ft. wide. The management plans to remodel the small mill, as a considerable tonnage of ore is blocked out.

The core-drill operating from the 1017-ft. level of the Jumbo Extension has gained a depth of 230 ft. and is advancing 7 ft. per day. It is expected to enter the shale-alaskite contact soon. Small shipments of $30 ore are being maintained from the old workings. Reports from the Copper Mountain mine, lately taken under bond, are encouraging. Including lessees, 100 men are at work, and considerable ore is going to the smelters.

JUNEAU, ALASKA

A 50-Stamp Mill for Sampling.—Local Engineering Society Meets.

The 50-stamp pilot-mill of the Alaska Juneau Gold Mining Co., at Juneau, was shut down on March 15, pointing to an early date for the starting of the new 8000-ton milling-plant. The management reports the mine in condition to deliver such tonnage as the mill will be able to handle upon starting up—probably around 1000 tons per day. The railroad between the mine and mill has been wholly re-constructed, ending in a steel trestle at the mill. Two of the bents of this trestle were designed to be built in the coarse-crushing plant of the pilot-mill, hence it was necessary to wait until that mill was shut down before completing this trestle. This has been done, and the railroad can now handle the ore. The train crews are working on the new rolling-stock.

One unit of the new mill is practically complete, and barring possible delay in receiving the small amount of machinery still due, the management expects the mill to be in operation shortly after April 1.

The members of the Alaska Mining and Engineering Society, members of the Alaskan Territorial Legislature and the Territorial Senate, on March 17, made a trip through Perseverance mine, the guests of the Alaska Gastineau Mining Co. After a trip through the mine, the party, numbering 125 in all, was banqueted at the mine mess-house.

C. T. Jackson, assistant general manager for the Alaska Gastineau Co., and president of the Alaska Mining and Engineering Society, presided. Interesting papers were read on 'Mining System and Costs at the Perseverance Mine,' by B. B. Nieding, superintendent; 'Underground Tramming Operation and Costs,' by R. R. Van Valkenburg; 'Methods Employed in Stope-Surveying,' by Ralph Healy, engineer at the mine; 'Mine Power Supply,' by W. S. Pullen, chief electrician; 'Mine Change-House,' by D. J. Argol, assistant superintendent; and 'Mine Accounting System at the Perseverance Mine,' by Ed Doherty, accountant at the mine.

COBALT, ONTARIO

Satisfactory Development in the Temiskaming.—Flotation at the Trethewey.

The main shaft of the Temiskaming mine has reached the 1600-ft. level and has connected with the drift at that depth which was run into Temiskaming from the Beaver workings. Excellent air circulation has been established and exploration and development at and below the lower contact will be pushed forward vigorously. A cross-cut will be run to tap the high-grade vein which is known to exist on the Beaver, that runs dircetly toward the Temiskaming. Meanwhile operations on the Beaver are proving the high-grade value of the ore to be consistant at the lower contact, and already a large quantity of 1000 to 2000 oz. ore has been mined at this level.

Cobalt. The Beaver has driven about 40 ft. on the first high-grade vein found on the 1600-ft. level. A short distance in, a second vein was found cutting across the original discovery at the lower contact. Near the intersection and between the two veins several feet of wall-rock carrying leaf silver was found. The second vein looks about as promising as the first, being several inches wide of fairly high-grade ore with accompanying milling rocks in the walls. A winze will be started close to the intersection. The contact is close to the roof of the drift, so no raising will be done at present.

The rock-house and hoist-house at No. 1 shaft of the Cordova Mines Co. caught fire at about 2 a.m., March 13. The building was a mass of flames before the fire was discovered, and the strong wind swept the fire across to the mill so rapidly that nothing could be done to prevent its destruction. The efforts of the management therefore were directed towards saving the adjoining buildings, and in getting three imprisoned miners out of the shaft. After the fire was smothered at the collar of the shaft, and the loose ground broken down, water and air-lines were laid through a winze and sub-level and the fire below the collar was extinguished. Air was then forced into the shaft, and aften ten hours strenuous work, the rescue party found the missing men. They had taken refuge in an underground magazine, from which they had excluded all smoke by chinking the cracks.

PORCUPINE, ONTARIO

Labor Shortage and Milling Extension at the Hollinger.

Eleven hundred men are employed at the Hollinger Consolidated as compared with 1300 six weeks ago. The shortage of labor is acute and there appears to be no immediate relief in sight. By the first of June, however, it is anticipated that the capacity of the mill will be raised another 1000 tons daily, or a total of 2700 tons, and it is expected the 3500 tons aimed at will be reached before the end of the coming summer.

The embargo on freight is lessening and as a result 12 carloads of machinery arrived in a single week. Eighty stamps of the new addition to the mill are in place, two tube-mills in position, and practically all of the building is completed. The Hollinger dividend has been temporarily reduced from 1% every four weeks to 1% every eight weeks. This will continue only until after the completion of the big expansion. During 1916 the Hollinger produced over $5,000,000.

The main drift at the 1000-ft. level of the McIntyre-Porcupine is 900 ft. long and is in ore all the way. The vein continues 28 ft. wide and maintains an average grade around $20 to the ton. Costs are a little over $4 per ton, and the mill-heads are being held down to about $10.60 per ton. The mill is treating at the rate of nearly 600 tons daily and the profit is estimated at nearly $4000 per day. It now appears as though the McIntyre will crowd the Dome Mines as the second largest gold mine in the Dominion of Canada. About 60 machines are employed and it is the intention of the management to continue the drift at the 1000-ft. level through every property included in the consolidation, which comprises the McIntyre, McIntyre Extension, Jupiter, and also the Plenaurum on which they hold an option. The ore-zone may thus be opened up for approximately one mile in length.

Contrary to the common belief, Hollinger reports will continue to be issued every four weeks, as heretofore, although the dividend periods will be eight weeks apart.

KIRKLAND LAKE, ONTARIO

New Power-Plant in Operation.—Tough-Oakes Increasing Output.

Power has been turned on at Kirkland Lake and already mining operations are showing marked improvement. The Tough-Oakes mill is running at full blast and is expected to show a large increase over the 1916 production which was $707,000. The Teck-Hughes mill is also in operation and will treat about 75 tons daily. A new mill is in the course of installation at the Lake Shore mine, and numerous small mine plants are being installed at the various properties. Very rich gold ore is being encountered in the drift at the 500-ft. level of the Kirkland Lake Gold Mines, Limited, and the shaft will be continued to the 600-ft. and deeper levels.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

The Alaska Mexican Gold Mining Co. reports for February as follows:

Tons ore crushed, 6755; tons concentrate saved, 182.98; estimated value of gold in concentrate, $10,029.39. Realizable value, $9929.10. Operating expenses, $8796.90. Estimated operating profit, $1132.20. Construction expense, $3127.53. Estimated loss, $1995.33. Other income, $4919.78. Yield per ton of ore, $1.48. Stock of broken ore, 5693 tons. The Mexican mill also crushed 6552 tons of ore from the United Co.'s Ready Bullion mine. This company's proportion of Central and Combination Development is included in the construction expense.

The Alaska United Gold Mining Co. reports for February as follows:

The Ready Bullion mill ran 27 days, 19 hours, and 2 minutes. On water-power 4 days; electric-power, 23 days, 19 hours, 2 minutes. The 700-Ft. Claim mill ran 26 days, 20 hours, 45 minutes, all by electric-power.

	Ready Bullion mill	700-Ft. mill
Ore crushed, tons	21,917	20,090
Mexican mill	6,552	
Total	28,469	
Free gold	none	none
Concentrate saved, tons	639.41	464.86
Estimated gross value concentrate	$54,411.25	$37,504.91
Realizable value	53,867.14	37,129.87
Operating expense	42,950.81	66,087.23
Estimated operating profit	$10,916.33	*$28,957.36
Construction expense	8,459.65	7,843.12
Total	$ 2,456.68	*$36,800.48
Other income	$ 2,040.75	$ 2,040.74
Yield per ton of ore milled	$1.91	$1.86

*Loss.

The Alaska Treadwell Gold Mining Co. reports for February as follows:

In the 300-stamp mill 225 stamps were run 27 days, 2 hours, and 6 minutes; running on water-power 8 days, 5 hours, and 10 minutes, and an electric-power 18 days, 20 hours, and 56 minutes.

Ore crushed, tons	34,790
Concentrate saved, tons	692.04
Estimated gross value of free-gold	$ 6,687.86
Estimated gross value of concentrate	56,183.94
Total production	$62,871.80
Total realizable value	62,243.09
Operating expense	38,100.90
Estimated operating profit	$24,142.19
Construction expense, etc.	13,543.52
	$10,598.67
Other income	$11,838.74
Total	$22,437.41
Yield per ton of ore milled	$1.81
Stock of broken ore decreased, tons	8,415

The diamond-drill down-hole No. 6 on the 2300-ft. level was advanced 474 ft. It showed an average value of $0.59.

The Alaska Juneau company recently completed a 1500-ft. raise, cut at an angle of 56° above the horizon. This is a somewhat unusual accomplishment.

ARIZONA

Mojave County

(Special Correspondence.)—The new equipment at the Tom Reed mill consists, not of Marcy ball-mills, as stated in the issues of March 24 and 31, but the coarse crushing will be done in a 5 by 6-ft. Allis-Chalmers ball-granulator, followed by two 5 by 6-ft. Allis-Chalmers ball-pebble granulators.

Oatman, March 26.

George F. Beveridge will place a hoist on the east shaft of the Diana mine in the Chloride district. The shaft is down 40 ft. and will be sunk to 500 feet.

Yuma County

Wenden. About six miles south of Wenden, Michael McCormick has discovered a large vein of mineral that is said by the State School of Mines to be magnesite. The vein is from 30 to 100 ft. wide and outcrops for some distance.

The Fortuna mine, which was worked with success for years by Chas. D. Lane, of San Francisco, and which has been idle for a long time, is again being prospected, with a view to larger operations.

CALIFORNIA

Butte County

The Oro Light, Water & Power Co. on March 26 recorded a deed conveying 3900 acres of dredging land in Butte and several thousand acres in San Joaquin and Calaveras counties to the American Gold Dredging Co. The latter corporation was organized to take over and dredge the lands of the Oro corporation after it sold its power holdings to the Pacific Gas & Electric Co. At the same time the American Gold Dredging Co. filed a deed of trust, covering its holdings, in favor of the Savings Union Bank & Trust Co. of San Francisco to cover a bond issue of $1,000,000 to finance the dredging corporation's operations.

Oroville. Announcement has been made, says the *Register*, that rich ore has been encountered at the 450-ft. level of the South Banner mine. The vein at this place is 9 ft. wide and the ore runs $20 to the ton. Richard Phillips is general manager. There are five stamps now installed and five additional stamps are being constructed at Grass Valley. In addition to this, pumping machinery has been ordered in Grass Valley. The pumping machinery will be installed at the Amoskey vein and the work of de-watering that shaft will be started.

El Dorado County

(Special Correspondence.)—Oakland people are becoming heavily interested in properties near Placerville. The Livingston gravel mine has been taken under bond and option, with work to start in 30 days. Years ago the mine yielded rich gravel at the surface. The Oakland syndicate has arranged for the driving of a 200-ft. drift from the 700-ft. level of the Pyramid mine, in expectation of intersecting the main orebody. The work will be done by contract.

The Teddy Bear Mining Co., of Seattle, has erected a small stamp-mill at the Teddy Bear, near Nashville. A good ton-

nage of free-milling ore is available. It is planned to carry the workings deeper this summer. Another Seattle corporation, the Deep Levels Gold Mining Co., has taken over the Los Padres mine, at El Dorado.

Placerville, March 28.

INYO COUNTY

J. Irving Crowell, of Los Angeles, has petitioned the State Water Commission for 1½ cu. ft. per second of the waters of Can Springs, 15 miles south of Rhyolite, Nevada, for use at gold, silver, and lead mines. A pipe-line half a mile long is proposed to convey the water to the place of use.

NEVADA COUNTY

The owners of the Red Ledge mine, two miles from Washington, on the road to Nevada City, are again taking out high-grade gold ore. The formation is slate that is intersected by small dikes of albite feldspar, and it is with the intrusions of albite that the gold occurs. Some pieces taken from the Red Ledge were worth several hundred dollars.

The case of Williams *v.* Brunnier, involving the title to one of the claims in the Conlan group of mines in Grass Valley mining distrct, has been decided by Judge George L. Jones in favor of the plaintiff. The plaintiff re-located the claim, alleging that the work for the year 1915 had not been done. Evidence introduced by the defense was to the effect that the work had been paid for, but evidence of its having actually been done was lacking, and the court awarded the claim to plaintiff.

PLUMAS COUNTY

Recent statements concerning a change of control and management in the Engels Copper Co. are officially stated to be wholly without foundation. There has been no change and there is none anticipated. Nor has there been any transfer of control in this company. John Reinmiller has been superintendent for nearly two years; E. E. Paxton has been for three years the general manager and will continue to direct the operations.

The Plumas Grass Valley Mines Co., of San Francisco, has made application to the State Water Commission for 2 cu. ft. per second of the waters of the south fork of Feather river for the development of power to be used in mining. The total fall to be utilized is given as 250 ft., and it is proposed to develop 50 horse-power. A ditch and pipe-line 4000 ft. long are proposed to carry the water from the point of diversion to the place of use and the estimated cost is given as $4000. The mine consists of an ancient auriferous gravel channel, the principal development is at and near Grass Valley, 10 miles north of La Porte.

TRINITY COUNTY

The State Water Commission has been petitioned by Frederick F. Holley of Peanut for 12 cu. ft. per second of the waters of Forest Glenn, or Mud creek, tributary to the south fork of the Trinity river for hydraulic placer mining. A dam of rock, brush, and timber is proposed to divert the water into a ditch and pipe-line three-quarters of a mile long, the estimated cost of the diversion to be $1500.

IDAHO

OWYHEE COUNTY

The Sinker tunnel has reached the veins of War Eagle mountain that were worked with profit in their upper parts some years ago. It is also reported that the Golden Cycle mine near De Lamar, has found high-grade ore.

NEVADA

MINERAL COUNTY

H. G. Cannon, of Sweetwater, has made application to the California Water Commission for 5 cu. ft. per second of the waters of Green and Ferris creeks, tributary to West Walker river in Mono county, California, for mining purposes. The proposed diversions are to be made by means of two rock or concrete dams and two conduits, each two miles in length.

CHURCHILL COUNTY

It is understood that work is about to be resumed on the Carpenter nickel mines, at the head of Dixie valley says the *Review-Miner*.

A watchman has been employed on this property for many years, and for a time, the difficulty of having the nickel ores smelted prevented active work. Preparations now are being made to put the property in shape, and again begin taking out ore, which in the event of war in which this country might be involved, would be of great value in furnishing a metal which Germany has for many years been supplying this country. Nickel deposits, of considerable extent, have been discovered from time to time in this State, but because the nearest smelters at the time were in Canada, there was not much incentive to work them, although with a high price on the metal, they would probably become paying propositions.

ESMERALDA COUNTY

GOLDFIELD. The Spearhead mine management announces a strike of rich ore on the 910-ft. level of that mine, where a 3-ft. vein has been found by cross-cutting.

HUMBOLDT COUNTY

ROCHESTER. The discovery of a large body of ore in the mines of the Rochester Mines Co. is announced.

Stoping in the old Four J block on the 420-ft. level developed the ore, which is 25 ft. wide. This lies in the hanging wall, and west of the ore removed by the former lessees on the block. The discovery of this orebody has added a large tonnage to the reserves developed. Reports from all parts of the property are to the effect that development work is progressing with satisfactory results, and that the usual supply of good ore is being mined.

MINERAL COUNTY

(Special Correspondence.)—The Western Ore Purchasing Co. has arranged to treble the capacity of its Hazen sampler, bringing it up to 900 tons daily. At present the plant is glutted with ore and the company is forced daily to refuse shipments. Manager F. M. Manson says that Candelaria and other old camps are again producing heavily.

H. K. Skinner is preparing to start shipments of silver-lead ore from the Badger mine, in the Marietta section. At a depth of 100 ft. the 186-ft. tunnel has intersected a small vein assaying $125 per ton, 60% of the value being in lead. A little gold also shows. At the Miller property nearby, similar ore is exposed.

A carload of gold-copper ore is being shipped daily from the Copper Belle group at Contact, 26 miles from Mina. The ore is mined from a glory-hole, where the deposit 40 ft. wide, assays around $35 per ton; 10,000 tons of shipping-ore is said to be exposed.

Mina, March 26.

NEW MEXICO

SOCORRO COUNTY

The Oaks company is making a shipment of ore to a custom-mill from the Eberle and Clifton mines. No stoping has been done on either property to date, all shipments being from development work. Large bodies of ore are being blocked out for mining on a larger scale when the facilities have been completed.

From operations covering the first half of March the Mogollon Mines Co. produced 13 bars of gold-silver bullion and four tons high-grade concentrate. New developments on the lower levels are adding to the ore-reserves.

At the Pacific mine a crew of over 20 men is employed. The work is being pushed as much as the allotment of power from the Socorro Co.'s plant will permit. In addition to develop-

ment of lower levels, stoping above the adit-tunnel was recently started, and the wire-rope tramway to Socorro's mill is in daily operation.

The initial shipment of ore to the custom-mill from the Maud S. mine, under option to the Oaks company, will likely be made the present week.

(Special Correspondence.)—A. H. G. Palmer, manager and one of the owners of the Alberta group of claims, adjoining the Socorro's property, has a party of prospective investors here inspecting the ground. Rumor is current that an active campaign of development will be started.

The Oaks company is rustling burros to make another shipment of ore to custom-mill. The ore was obtained in course of development work on the Clifton and Eberle mines.

Socorro Mining & Milling Co. shipped 14 bars gold-silver bullion to the mint from operations covering the first half of March. Its aerial wire-rope tramway from the Pacific mine is in operation, transporting a good tonnage of ore from the latter property.

Preliminary work at the Maud S. mine is well in hand, and some prospecting-mining is being done to determine the best points at which to begin active development. Much is expected of this property, in view of its excellent record of production in the past from only a limited exploration of its veins. The Oaks company is exercising a bond and lease on the mine.

Mogollon, March 23.

OREGON

Josephine County

(Special Correspondence.)—Near Takilma the Queen of Bronze mine is working 50 men, and producing a good grade of copper ore. The Waldo and Cowboy copper mines are also being worked. The Logan hydraulic mine is being prospected with churn-drills. It is from 30 to 40 ft. to bedrock, and the gravel is mostly small, so good headway is being made. The hydraulic-pit at this mine is 500 by 1000 ft. One elevator is in operation working under a head of about 250 ft. Ten men are employed. Chrome mines in this vicinity are active.

Waldo, March 26.

TEXAS

Archer County

(Special Correspondence.)—There is much activity among mining men in securing leases upon large tracts of land in this region, where deposits of copper ore are known. John Eilman, of Lander, Wyoming, is preparing to install machinery with the view to developing copper deposits that are found upon a tract of 2300 acres that he recently leased. The fact that the ore occurs as nodules in a clay formation has caused the dredging method of mining to be adopted. The clay in which the ore is found is put through the washing-process and in that manner the almost pure copper is obtained ready for shipment. Copper ore-buying agencies are now established in all of the towns adjacent to the copper-bearing district and these concerns are shipping considerable quantities of ore.

Archer City, March 26.

WASHINGTON

Ferry County

(Special Correspondence.)—The width of the vein encountered by the Lone Pine-Surprise Consolidated Mining Co. in the Last Chance shaft is now determined to be about 5½ ft. The vein is solid and averages $13 per ton. The mine is equipped with a 514-cu. ft. Ingersoll-Sergeant duplex air-compressor, with cylinders 12 by 12 by 18 in., a Vulcan hoist and ¾-in. round wire-rope, a 90-hp. Pacific Engine & Boiler Co.'s boiler. The machinery is well housed, and there are an office, blacksmith, and carpenter shop on the ground. The head-frame is 37 ft. high. The shaft has a 4½ by 4½ ft. hoisting-compartment and a 3½ by 4½-ft. manway and pumping-compartment, and the ore and waste are hoisted in a self-dumping skip, a special device in the head-frame being provided for this purpose. A drift is being driven south-east on the vein, from which the ore-loaded cars will be run to the station, backed over a 15 by 15 by 12-ft. pocket and dumped. An aerial-tramway is under consideration, its purchase awaiting arrangements for right-of-way and construction of ore-bunkers in Eureka gulch, for the delivery of the ore to railway cars.

The Northport Smelting & Refining Co. is sinking a double-compartment working-shaft on the Lone Pine vein, now down nearly 700 ft. Shipments from the Lone Pine for the week ended March 22 amounted to 350 tons. During the same period Knob Hill shipped 240 tons.——Work has been resumed in the Belcher mine, in the Belcher mining district.

Republic, March 27.

Stevens County

(Special Correspondence.)—The discovery of a great deposit of magnesium carbonate is reported from Valley. There is said to be not less than 4,000,000 tons in the mass. The mineral differs in every respect, except composition, from the California magnesite. It is coarsely crystallized, and slightly bluish or grayish in color, looking like some rather coarse-textured marble. It contains only a small amount of lime and silica, though the iron content is just right to make the refractory bricks and linings used in metallurgical furnaces. The American Mineral Production Co. has commenced to ship the crude mineral, and has contracted with the Schaeffer Co. of Tiffin, Ohio, for calcining furnaces and complete plant. An average analysis of this magnesite is: silica 0.8%, alumina 0.4%, iron-oxide 2.7%, lime 3.3%, and magnesium carbonate 92.1 per cent.

Valley, March 26.

CANADA

Ontario

A few days ago the report of a fabulous strike of gold in the Hollinger mine was circulated. The truth is that a streak of very rich ore was actually found in the Hollinger mine, but it was of no such dimensions and importance as the reports had led many to believe. The strike was made on the 400-ft. level, where a streak of ore one-half inch wide, a foot high, and 6 ft. long was found crossing the vein. This streak, although not large, was nevertheless nearly all gold. The vein-rock in the vicinity of the pocket was also rich in gold.

Yukon Territory

The report of the Canadian Klondyke Mining Co., showing that it has been able to maintain an unbroken period of dredging operations in Alaska throughout the winter will result in greatly increased earnings for the various Alaskan gold dredging companies. The previous operating record of this company was 120 days for the entire year. The Yukon Gold Co. established a new record last year when it operated in the Yukon district for 180 days. The Canadian Klondyke Co. is a subsidiary of the Consolidated Goldfields of South Africa, Limited, and the method used this year was a new system of thawing with steam. Two of the largest dredges of this company were used, of a capacity of 17-cu. yd. buckets on each dredge. The results have been so satisfactory that the dredging capacity of the company will be increased immediately. The Alaska Mines Corporation has been experimenting with this method and it was thought that this company would be the first to apply it but the Dawson people have taken the initiative.

CHILE

The American Metal Co. is represented in Antofagasta by a group of engineers who are making a detailed study of the *Mantos Blancos* mining region, about 70 kilometres (43.4 miles) along the railroad to Bolivia. These are the preliminaries of what may be a big mining negotiation which will

be of great importance for the Department. The mines belong to Don Carlos de la Fuente and the Sociedad Chilean de Fundicion.

A mining company has been formed at Iquique under the name of Huanillo. It owns a large deposit of iron (magnetite) that has recently been discovered. This large deposit is of the best class of iron ore and does not go below 75%. Engineers have calculated that there are over 300,000,000 tons. The deposit is situated in the province of Tarapaca, 10 kilometres (6.2 miles) from the coast.

The first shipments of copper ores from the famous Queuco mines have arrived in Temuco. The owner, Sr. Pedro Rosas, who is also the administrator of a number of the mines, says that he has shipped 40 tons to Temuco and expects to complete 200 tons in March, as the transportation had to be stopped during the months of January and February on account of the harvests. The ore which has been extracted contains 45% copper.

Marco Emilio Corvalán has installed a smelter in Cabildo, using a reverberatory furnace of his own invention. It is 15 metres (48.3 ft.) long by 6 metres (19.3 ft.) wide and is provided with ten hoppers for charging the furnace and with a 6-metre (19.3 ft.) stack, says *El Mercurio*. Heat is supplied by four burners, also of a type invented by the owner, using petroleum. The first test lasted five consecutive days and nights without the furnace showing any signs of failure, the products being 380 tons of copper matte assaying 55.72% copper. The slag, which ran out continuously, was glassy and contained a very small percentage of copper (0.24%) and was carried away by a current of water to cars that carried it to the dump. The average grade of copper in the ores treated, including the fluxes, during this test was 2.5%. Large quantities of ore are being received which is stacked in piles of about 500 tons, already mixed with the necessary fluxes.

SOUTH AFRICA

Glynn's Lydenburg (Ltd.) in the Transvaal, reports for February as follows: Tons milled 3870, estimated value £7286; estimated profit £2919.

The Transvaal Gold Mining Estate (Ltd.) reports for February: tons milled 15,000; estimated value £30,630; estimated profit £8338.

Rand Mines (Ltd.) sends out the following report of operations for February:

	Tons milled	Estimated value	Estimated profit
Modderfontein B Gold Mines, Ltd..	40,500	£87,379	£47,442
New Modderfontein G. M. Co. (Ltd.)	53,200	121,506	65,631
Rose Deep, Ltd.....	56,300	63,287	14,597
Geldenhuis Deep, Ltd.....	54,000	66,691	12,794
Nourse Mines, Ltd.....	36,100	54,058	10,048
City Deep, Ltd.....	59,000	113,681	55,200
Village Deep, Ltd.....	45,600	68,577	16,785
Ferreira Deep, Ltd.....	47,560	80,792	29,908
Robinson Gold Mining Co., Ltd....	51,600	59,725	22,087
Crown Mines, Ltd.....173,000		233,730	65,791
Durban Roodepoort Deep, Ltd....	25,200	34,368	3,893
Bantjes Consolidated Mines, Ltd..	20,230	19,513	*4,368

*Estimated loss.

In the City Deep, Ltd., the profit includes £2114 profit-accumulations.

The increased loss for the month in the Bantjes Consolidated Mines, Ltd., is due to low grade of ore mined, small tonnage milled, and some abnormal expenditure; also cost of increased native force from which little results have been obtained. The native labor position is now satisfactory, and incline shaft repairs completed. The March tonnage is expected to be higher and 6 additional leader stope-faces will be available for mining within 5 to 6 weeks. Payable value continues to be exposed in portions of leader development.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

MORTON WEBBER is here.

E. W. MILLS has gone to Peking.

LOUIS A. WRIGHT is at Santiago, Chile.

W. W. MEIN has returned to New York.

WALTER G. PERKINS is at the Palace Hotel.

OTTO SUSSMAN has returned to New York from Joplin.

D. M. HYMAN of New York was in San Francisco this week.

A. W. EDELEN is returning to Mexico City, Mexico, in the interest of the American Smelting & Refining Company.

ROSS HOFFMANN has returned to Petrograd from Central Siberia.

SPENCER C. BROWNE, of the Nickel Corporation, is here from New York.

JOHN H. MACKENZIE is at Juneau and will remain there until the end of May.

E. S. PETTIS is in Chicago in the interests of the Oliver Continuous Filter Company.

A. E. WHEELER, in charge of the Tanganyika smelting operations is visiting Montana.

L. D. RICKETTS is so seriously ill that he has had to abandon his expected journey to Chile.

W. B. DENNIS has been elected a member of the Oregon Bureau of Mines and Geology Commission.

E. HAMPTON, who recently resigned as superintendent of the Bunker Hill mine, at Amador City, has gone to Nevada City.

M. WADA, general mill superintendent for the Ashio Copper Mines, Japan, is making a metallurgical tour in this country.

OTTO F. HEIZER is general manager for the Louisiana Consolidated Mining Co. that is re-opening the old Tybo mine, in Nye county, Nevada.

FREDERICK LAIST and WILLIAM WRAITH are on their way to Chile, where they will inspect the Potrerillos mine of the Andes Copper Company.

CHAS. G. YALE is seriously ill at his home in Oakland as the result of being run down by an automobile in Oakland on the evening of March 26.

TATSURO OTAGAWA, of the Department of Mining of the North-Eastern Imperial University of Japan is visiting the mines of Utah and Montana.

H. Y. EAGLE, S. WARD HAAS, and P. E. WELDY are constructing engineers under A. E. WHEELER, of the new smelting plant of the Union Minière, or Tanganyika company, in the Belgian Congo. They are in New York at present.

J. MORGAN CLEMENTS, mining geologist and engineer, will have charge of a survey of the mineral resources of the Far East, including China and Siberia, under the auspices of the Bureau of Foreign and Domestic Commerce, at Washington.

THE second annual meeting of the Pacific Division of the American Association for the Advancement of Science will be held this year at the Stanford University, California, during the period, April 4 to 7. Among the scientific societies which will also convene in conjunction with this meeting are the Astronomical Society of the Pacific, the Pacific Coast Section of the American Mathematical Society, the American Physical Society, the California Section of the American Chemical Society, the Cordilleran Section of the Geological Society of America, the Seismological Society of America, the Pacific Coast Branch of the Palaeontological Society, the Western Society of Naturalists, the Cooper Ornithological Club, the Pacific Slope Branch of the American Association of Economic Entomologists, and the California Academy of Sciences. Sessions of these societies will be held on Thursday, Friday, and Saturday of the period of the convocation.

THE METAL MARKET

METAL PRICES

San Francisco, April 3

Antimony, cents per pound	24
Electrolytic copper, cents per pound	38
Pig lead, cents per pound	9.25—10.25
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	115
Spelter, cents per pound	13
Tin, cents per pound	50
Zinc-dust, cents per pound	18—20

ORE PRICES

San Francisco, April 3

Antimony, 50% metal, per unit	$2.00
Chrome, 40% and over, f.o.b. cars California, per ton	18.00—20.00
Magnesite, crude, per ton	8.00—10.00
Tungsten, 60% WO_3, per unit	17.50—18.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 50% (under 35% metal not desired)	29.00

Manganese ore, 40 to 45%, sells f.o.b. Chicago at 58c. per unit with a penalty of 50c. per unit for more than 8% silica.

EASTERN METAL MARKET

(By wire from New York)

April 3.—Copper is lower and dull. Lead also is quiet at 9.40c. and zinc is stagnant at 10.75c. The price of platinum remains unchanged at $105 to $111.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
Mch. 28	35.00	Feb. 20	35.37
" 29	35.00	" 27	36.00
" 30	34.50	Mch. 6	36.29
" 31	34.50	" 13	36.25
Apr. 1	Sunday	" 20	35.87
" 2	34.25	" 27	35.62
" 3	34.25	Apr. 3	34.58

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

Directors of the Anaconda Copper Co. have declared quarterly dividend of $2. Three previous payments were $2 each.

AVERAGE COPPER PRICES

'The American Metal Market' presents the following figures of 10-year averages of copper which explain themselves:

10 years ending	1909	15.47½
" " "	1910	15.11
" " "	1911	14.72
" " "	1912	15.17½
" " "	1213	15.36½
" " "	1914	15.39
" " "	1915	15.53½
" " "	1916	16.40½

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
Mch. 28	72.62	Feb. 20	78.41
" 29	72.37	" 27	77.37
" 30	72.37	Mch. 6	76.50
" 31	72.37	" 13	75.06
Apr. 1	Sunday	" 20	72.91
" 2	74.12	" 27	72.06
" 3	74.12	Apr. 3	72.98

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

Theorists in regard to currency problems are contemplating the possibility of the re-monetization of silver following the cessation of the European war. The world conflict has had a profound effect on the market for the white metal. In February of this year the price rose to a record level for the past quarter century, and while rapid decline from that figure quickly followed this feat, many authorities are still free in their predictions that silver will advance to at least one dollar an ounce after the War.

Weakness in Chinese exchange has been a factor in depressing silver prices from their recent high level to below 73c. per oz. The advancing cost in shipping silver abroad, particularly to England, has also had its effect. It now costs about 3¼c. per oz. to export silver from New York to Europe, 1¼c. for freight and 2c. for insurance. The freight rate approximates 2% ad valorem and the insurance 2½% in British bottoms.

The great demand that has existed in India for silver currency during the War did not become really keen until toward the close of 1915. This shows the close link that exists between the demand for currency and high prices for commodities. There is no reason to suppose that recent withdrawals of coin from circulation were other than what is customary, namely, the peasant classes have put by surplus profits against less favorable times. Now that prices have risen so considerably, the margin of profit is larger than usual, and a greater amount of coins is therefore necessary.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
Mch. 28	9.40	Feb. 20	9.58
" 29	9.40	" 27	9.45
" 30	9.40	Mch. 6	11.54
" 31	9.40	" 13	9.50
Apr. 1	Sunday	" 20	9.75
" 2	9.40	" 27	9.50
" 3	9.40	Apr. 3	9.40

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

On April 4 the Bunker Hill & Sullivan Mining & Concentrating Co. will pay dividend No. 248 of $81,750. On the same day, the company will pay an extra dividend, No. 249, of $81,750. These two dividends will make the total dividends paid to date $19,143,750.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound

Date		Average week ending	
Mch. 28	10.75	Feb. 20	10.54
" 29	10.75	" 27	10.70
" 30	10.75	Mch. 6	10.85
" 31	10.67	" 13	10.87
Apr. 1	Sunday	" 20	10.69
" 2	10.67	" 27	10.74
" 3	10.67	Apr. 3	10.71

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

The annual report of the American Zinc, Lead & Smelting Co. for the 1916 calendar year shows total operating profit of $9,307,967, compared with $5,293,878 in 1915 and $77,692 in 1914.

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date			
Mch. 6	115.00	Mch. 20	115.00
" 13	105.00	" 27	120.00
		Apr. 3	115.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	....	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Eastern Metal Market

New York, March 28.

The entire metal-market is quiet and dull, more pronounced in some cases than others. Buyers seem inclined to await international development next week that are of vital significance before entering on any commitments of consequence. Not much actual business has been done in any metal, but the general tendency has not been toward weakness.

Copper is easier and a little lower, especially for April and second quarter.

Zinc is inactive and still stagnant.

Lead continues steady and fairly firm.

Tin remains strong but large arrivals yesterday have eased the situation.

Spot antimony continues to advance and is hard to obtain at any price.

In the steel market, the relations of the United States Government with the steel makers as to purchases for Government needs, is the absorbing topic. Today an important conference is being held by leading steel men as to the prices at which steel products are to be supplied to the Government, similar to the action last week by the copper producers. It is important to consider that the total consumption for such purposes is not likely to exceed 2% of the steel-making capacity of the country, and hence is not a vital market factor. Prices in general continue to advance, one of $5 per ton for billets and sheet-bars being important. Pig-iron also is rising, basic iron having gone up not less than $3 with sales at $35.

COPPER

The principal topic of conversation the past week in the copper market has been the sale, referred to last week, of 45,000,000 lb. to the United States Government at 16.67c. per lb. or 50% less than the market price. While the action is generally regarded as patriotic, not a few dealers in this district point out that the move was a clever one on the part of at least three large producers. Making this sale at what is regarded as the average price for the last 10 years is believed to have staved off Government seizure of copper-producing plants. The strike at the Laurel Hill, Long Island, refinery of the Nichols Copper Co. has been settled and deliveries from that source are coming into the market again. In general, business has been slow the past week with little or no interest. Very little new business is appearing. The general easing of the market is not due to the sale to the Government. This is so small with reference to the total output that its effect is inconsequential. The Government's requirements call for 4,000,000 lb. per month and the monthly production is nearly 200,000,000 lb. The quotation yesterday for nearby copper was 35.50c., New York, with second quarter at 34 to 35c., and third quarter at 30 to 31c. The softened tendency is explained as due to large offerings for second quarter. The London quotation for spot electrolytic is unchanged at £151.

LEAD

A leading subject discussed by lead dealers the past week is the action of the copper producers in selling to the Government at the low price they made for delivery over the next 12 months. Lead producers are expected to be asked to do the same, if negotiations are not already under way or completed. That a similar action will result is generally conceded, but the probable price is placed speculatively at various figures. A slump in the market would have taken place before this, it is generally acknowledged, were it not for the fact that producers are generally well sold up and are not under the necessity of going out to solicit orders. Arrivals from the West are better and now sufficient to meet all demands. Spot and March metal is quoted at 9.50c., with 9.25c. asked for April and 9c. for May and June delivery. The leading interest continues to quote 9c., New York. Spot lead in London is unchanged at £30 10s. per ton.

TIN

The market has been generally dull and uninteresting and not much business has been done. On March 21 about 200 to 300 tons was sold, mostly off-grade, to a Western consumer, but other buying was slow. Thursday and Friday were dull days, with Monday, March 26, not much better, although about 100 tons in all was reported sold on that day. The anxiety manifested lately regarding the steamer Philadelphian with 815 tons on board, was relieved by the arrival of that vessel on Tuesday. On the same day the Eurybates also made port with 1000 tons. These arrivals have considerably eased the spot-market, which yesterday was 55.87c., having been as high as 56.50c. on Monday. The entire situation is more comfortable. The quantity afloat is now 2436 tons, with 3580 tons reported arrived during March. On Monday more interest was shown with wide inquiry for all deliveries and descriptions, but no business resulted. The month as a whole has been a dull one with sales generally small. The London market continues to advance. Spot Straits was quoted there yesterday at £218 5s. against £214 2s. 6d. a week ago and £201 two weeks ago. Information as to sailings from England are being held up and arrivals here are not given out in full as formerly. It is understood, however, that details of cargoes are to be released once each week.

SPELTER

There is little that can be said about an absolutely stagnant market. Very little business is being done, though about the middle of last week there was a more active market at slightly higher prices. Since then there has been no change and the metal is quoted at 10.75c., New York, for prompt and March, with 10.50c. for April and 10.25c. for second-quarter delivery. Brass makers continue to take no interest and their future wants are uncertain, some of them operating no longer at full capacity. The relation between ore and metal-prices continues at a deadlock. High-grade spelter is selling at 16 to 18c., depending on quality, and fairly large contracts are reported as having been placed. Brass-special is quoted at 11 to 11.25c., St. Louis, for prompt delivery, but is in no demand. Sheet galvanizers were reported yesterday as inquiring for second-quarter metal.

ANTIMONY

The spot metal continues to advance and is quoted nominally at 34 to 35c. per lb. Small sales have been made at these figures, and one sale is noted at 38.50c. The metal is hard to get for immediate delivery. There seems to be a good demand for March shipment, but uncertainties in deliveries make dealers shy of futures. March shipment is quoted at 15.50 to 16.50c. Shipments that used to require only six weeks from the Orient now take often as much as three months. The Eurybates, with at least 300 tons, arrived yesterday, but it has probably all been sold.

ALUMINUM

There is little change. Spot metal is a little higher, if anything, at 59 to 60c. for No. 1 virgin, 98 to 99% pure, because a little scarcer in this market.

The personnel of the Pacific Northwest Mining & Metallurgical Experiment Station, Bureau of Mines, at Seattle, is as follows: Dorsey A. Lyon, metallurgist and superintendent of station; George Watkin Evans, coal-mining engineer; Francis C. Ryan, electro-metallurgist; Harlan A. Depew, chemist; Union B. White, clerk.

Book Reviews

THE MINING MANUAL AND MINING YEAR BOOK, FOR 1917. By Walter R. Skinner, 12-mo, pp. 950. Price, $6.

The annual appearance of this book is always welcomed by those interested in world-wide mining. While published for the use of the public in London, it is invaluable as a book of reference to many outside Great Britain. We have always found it a mine of necessary information. Every year it becomes more accurate and more comprehensive. Besides the record and description of the various mining companies, the 950 pages furnish statistical data, a glossary of mining terms, and a directory of directors, secretaries, and engineers engaged in mining.

CHEMICAL TESTS FOR MINERALS. By Arthur J. Burdick, pp. 93. The Gateway Publishing Co., Beaumont, California. For sale by the MINING AND SCIENTIFIC PRESS. Price, $1.25, postage 7 cents.

This book is designed to meet the requirements of prospectors who want to be able to recognize the minerals they find while searching among the hills. To the inexperienced eye many valuable minerals bear a close resemblance to others that are of no value. For instance, galena and specular iron often look much alike when disseminated through a rock. It is to help the prospector to determine what the minerals are that he finds that this little work has been published. The book is well arranged and is in such form that almost anyone of intelligence can apply the tests suggested, and thus get the desired results.

ENGLISH AND ENGINEERING. Edited by Frank Aydelotte. 12-mo, pp. 390. Price, $1.50. Published by the McGraw-Hill Book Company, New York.

This attractive little book is a collection of examples of good writing, intended "to help technical students in expressing themselves better in writing and speaking, and of broadening their outlook on life." The reviewer is so much in sympathy with the purpose of the book that he regrets to criticize it, as he must, for mixing excerpts from such writers as Ruskin, Huxley, Matthew Arnold, Carlyle, Robert Louis Stevenson, and Emerson with the writings of sundry engineers and professors of engineering still alive and altogether lacking the genius of the masters of the art of writing in whose company they are thrust by the well-intentioned editor. The contrast between Huxley and Dr. Mann, between Ruskin and Mr. Harrington, is ludicrous; and the two latter-day engineers should have been spared the comparison.—T. A. R.

Recent Publications

STATISTICS OF RAILWAYS IN THE UNITED STATES, 1905-1915, Washington, D. C., 1916.

MINERAL PRODUCTION OF CANADA IN 1916, A PRELIMINARY REPORT. Department of Mines, Ottawa, 1917.

THE PRODUCTION OF COAL AND COKE IN CANADA IN 1915. Department of Mines of Canada, Ottawa, 1916.

MINE STATEMENTS. By W. D. S. MacDonald, Minister of Mines, New Zealand, Wellington, New Zealand, 1916.

THE MINERAL RESOURCES OF THE PHILIPPINE ISLANDS IN 1915. Bureau of Science, Division of Mines, Manila, P. I., 1915.

COMBUSTION IN THE FUEL BED OF HAND-FIRED FURNACES. By H. Kreisinger, F. K. Ovitz, and C. E. Augustine. Bureau of Mines. Tech. paper 137, Washington, D. C., 1916.

COAL-MINE FATALITIES IN THE U. S. IN 1916. By Albert H. Fay. Bureau of Mines, Washington, D. C., 1917.

METAL-MINE ACCIDENTS IN THE UNITED STATES IN 1915. Bureau of Mines. Tech. paper 168, Washington, D. C., 1917.

FELDSPAR IN CANADA. By Hugh S. de Schmid. Mines Branch, Department of Mines of Canada. Pp. 125. Ill. and maps. Ottawa, Canada, 1916.

METAL STATISTICS FOR 1917. Being the tenth annual edition of this useful little volume, published by *The American Metal Market* and *Daily Iron and Steel Report*, 81 Fulton street, New York.

Industrial Notes

Information supplied by the manufacturers.

M. B. Myers, formerly assistant to the vice-president of the AMERICAN MANGANESE STEEL CO., has been appointed sales manager for the company.

The WILLIAM POWELL CO. of Cincinnati, Ohio, has issued a handsome tri-color circular, in red, blue, and gold, descriptive of its White-Star valve, that is particularly adapted to working under high pressure and high temperature. The disc, which is regrindable, reversible, and renewable, is made of 'Powellium' white bronze with a melting-point of 2000° F.

The DEISTER CONCENTRATOR CO. has just issued a new bulletin descriptive of the Deister-Overstrom tables. The company has closed a contract with the American Zinc Co. of Tennessee, at Mascot, Tennessee, for 56 of these tables. Pages 14 and 15 of the new bulletin cannot fail to interest all that are interested in concentration. The bulletin will be sent on request.

The TRAYLOR ENGINEERING & MANUFACTURING CO. of Allentown, Pa., has opened branch offices in the West at the following places: Headquarters at Salt Lake City; at Spokane, Washington, for the North-west district, with C. H. Abeling in charge; at El Paso, Texas, for the South-west district, in charge of Robert M. Peabody. The Western business is under the general direction of John A. Traylor, who also represents the Cement Gun Company.

The INGERSOLL-RAND CO., 11 Broadway, New York City, has recently issued two new catalogs on Dry Vacuum Pumps, Form No. 3037 covering the straight-line type and Form No. 3038 on the duplex type. Both machines are equipped with 'Ingersoll-Rogler' valves, are capable of maintaining a high vacuum, and will handle discharge pressures of several pounds. The maximum degree of vacuum possible varies with the different machines, to within 0.6 inches of the barometer. These catalogs will be sent on application.

The Tonopah Bonanza Mining Company of Tonopah has placed an order with the YUBA MANUFACTURING CO., 433 California street, San Francisco, for two turbine-pumps, each pump to have a capacity of 500 G.P.M. against a total head of 1700 ft. Also the Tonopah Great Western Mining Co. of Tonopah, has ordered from the same company a turbine-pump to have a capacity of 550 G.P.M. against a total head of 1200 ft. The Yuba Manufacturing Co. has not completed its bulletin of mine-pumps but has an interesting catalog of general-service pumps that will be mailed on request. The mine-pump bulletin will be out shortly.

The largest electric-hoist under construction for installation in this country is that being built by the NORDBERG MANUFACTURING CO. for the Butte & Superior Copper Co. of Butte, Montana. This hoist is designed for an initial rope-pull of 41,000 lb. and a rope-speed of 2200 ft. per minute when hoisting from a depth of 3000 ft. It has two double-clutched drums, 9 ft. in diameter, and is driven by an 1800-hp. motor, direct-connected to the drum-shaft. When the ultimate depth of 5000 ft. is reached, the drum diameter will be increased to 12 ft. and the hoisting-speed to 3000 ft. per minute and the rope-pull will be increased to 52,000 lb. and a duplicate driving-motor will be added to the opposite end of the drum-shaft.

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Edited by T. A. RICKARD

Volume 114
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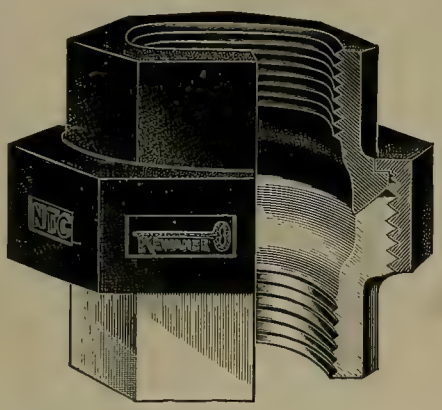

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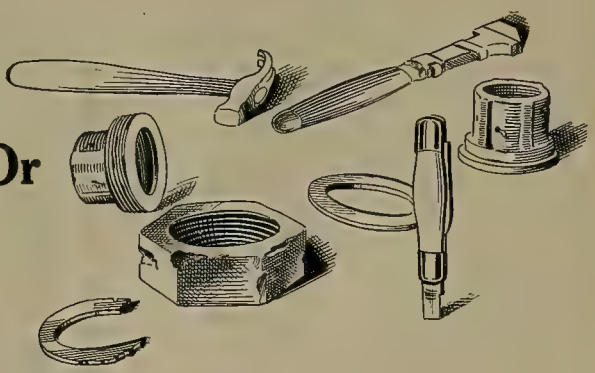

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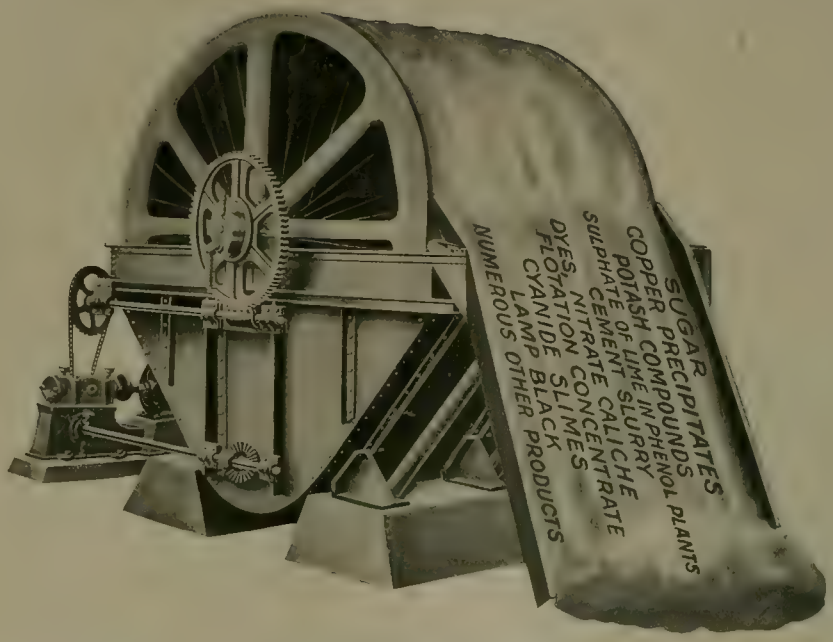
The Ventilation of a Mine

The Oliver Defines Economy



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UNION CONSTRUCTION COMPANY

The Union Construction Page

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EDITORIAL

T. A. RICKARD, Editor

WITH an iron production of 40,000,000 tons per annum, and a stock of gold amounting to $3,075,000,000, the 100,000,000 of people in the United States constitutes a resourceful fighting unit for democratic ideas.

DESPITE the higher cost of aluminum its use as a substitute for zinc in the precipitation of gold and silver from cyanide solutions promises to become important. The advantages, which exceed those of mere regeneration of cyanide, are set forth by Mr. P. H. Crawford elsewhere in this issue. Methods of analysis of aluminum intended for this work are given in a recent article by Mr. J. E. Clennell in the *Engineering and Mining Journal.*

RECENTLY a Japanese engineer called upon us and discussed mining matters. We suggested that among other places of interest he should visit the University of California. He said: "At Stanford." We said emphatically: "No, the State University is at Berkeley." "Oh," he replied, "I thought the great University of California was at Stanford; is not that the university from which Hoover came?" We conceded the point with mixed sentiments. Our visitor was a man of insight; the great university is the one that produces great men. He was right. To that we add that a great university is one that makes public opinion, that has no liking for 'listening leadership,' that is to the front in national and epochal affairs. Stanford has done that too.

THE United States of Colombia is seeking geologists to fill positions on its recently authorized Scientific Commission, now being organized to undertake a geological reconnaissance of that rich republic. Few areas of equal size in the world are so splendidly endowed with mineral resources. In the hands of capable technologists the projected survey should prove stimulative of new and useful enterprises. Climatically many portions of Colombia are undesirable. Unfortunately most of the gold districts are included in the miasmatic areas. This will prevent a wild scramble for positions on the survey, but it must be noted that the great plateau of Bogotá is of unsurpassed salubrity, and the central districts of Santander, the upper Cauca valley, and large parts of Tolima and Cundinamarca are not unsuitable for the men of our race.

ABSORPTION of the Tamarack Mining Company, by the Calumet & Hecla, is only the conversion of control into actual ownership, yet it is an important step. It eliminates one group of stockholders, including some belligerent spirits, and strengthens the position of the purchasing corporation. The sale has long been contemplated, and arrangements had been made for its consummation last year when a restraining suit was entered by Mr. G. M. Hymans on the ground that the Calumet & Hecla was both vendor and purchaser, which would make the transfer void. It was generally believed that the transaction would not be carried through, but announcement is now made that the Tamarack has been acquired for the sum of $3,600,000, authorized by a vote of 48,061 shares out of 60,000. The Calumet & Hecla owned 19,400 shares in the company. The Tamarack was incorporated in 1882, and has paid $9,420,000 in dividends.

INFORMATION concerning the course of events may sometimes help and sometimes hinder the performance of duties that the people may render in the coming conflict, but misinformation can only work harm to all concerned. The times are tense enough without sensationalism. Passions may be aroused by it that need never have been stirred; timidity that may lead to panics injurious to the welfare of the nation may be occasioned. Within these first few days after the acceptance of a state of war the daily press has frequently made clarion announcement of exciting things that later dwindled from three-inch type into six-point paragraphs and then disappeared. We should be protected against canards. It will make for calmer action and superior service if the newspapers be placed under so much official supervision at least as requires that news verified by the constituted authorities be printed with that fact made apparent by an appropriate note at the end of each dispatch.

MILITARY service was a dominant note at the meeting of the Pacific Division of the American Association for the Advancement of Science at Stanford University last week. Each of the co-ordinated societies brought forward its proposals for utilitarian work in the common cause. The seismologists, because of their familiarity with the habits of earthquakes, had been asked by the Ordnance Department to suggest means for detecting the position of distant artillery in action; the physicists were ready with the hope of locating the gun through the medium of the air-wave instead of the earth-tremor. The astronomers are enlisting in the service of Mars, with superior understanding of optics as a first contribution. Dr. W. W. Campbell, director of Lick Observatory, is taking a census of military ideas among the members of his staff for transmission to the authorities. Everywhere the word was passed that men of technical training must start to think for the benefit of the

country, and not to shrink from proposing new ideas for fear that they might in the end prove unsound. One thought leads to the next; the germ of the useful idea may lie in the plan that fails on the initial trial. It was even hinted that the paleontologists be resurrected and interrogated for practical ideas, to which they replied by pointing to their services in the search for oil.

MOLYBDENUM delivered by dirigible balloon is the suggestion of an Alaskan miner who claims to have a twelve-inch vein of solid molybdenite. This metal has had a market-career as uncertain as aeronautics, so the air-route may well fit the case. On the other hand, no doubt exists that the longevity of the large-bore German guns in this war, which at first surprised the world and then led to prompt imitation of German metallurgic practice, has been due to the use of molybdenum. It makes a steel that resists expansion, crystallization, and deformation under the influence of great pressure from high explosives, better than any other alloy that has yet been discovered. Quite apart from other valuable qualities this military use alone will create a demand for molybdenum that must be met—by balloon or otherwise. We believe, however, that the great stores of this material accumulated in certain Eastern warehouses will be more readily available as a first resource than those of the Alaskan tundra.

A NEWS-ITEM states that "the present company has been operating about six months and is now making a scientific search for the lost orebody which so suddenly and mysteriously disappeared about the time the mines were at the zenith of their fame." Much humor is unconscious. No ordinary scientific search will avail to find orebodies of this kind—these that appear so vividly in the reports of imaginative superintendents at a time when the stock-market is sensitive and disappear with the wave of a promoter's wand when the jig is up. Such orebodies remind one of King Arthur's city, which "was built to music, therefore never built at all, and therefore built forever." They cannot be demolished by the blows of fact. They are re-discovered by the method that led to their original disclosure. Even much water cannot extinguish them; they grow under water and assume lordlier dimensions, until in the words of the Johnsonian auctioneer they become "potentialities of wealth beyond the fondest dreams of avarice." Most of us have sought them. Lucky is he that found the boojum and was not grieved to find it only a snark.

NEVADA has yielded to the perennial complaint of the ore-shipper by the enactment of a law intended for his protection against the greedy smelter. It is at best an innocuous statute. It may cost the taxpayers an extra driblet; it will frequently divert the wrath of the shipper from the ore-buyer to the luckless State Assayer, now created to stand between the robber and the robbed. He is to draw a salary of $3000 per year, and on demand of any shipper is to become his representative to weigh, sample, and assay against the purchaser. For this service he will receive 25 cents per ton of ore, plus expenses of travel and maintenance when called to a point at which the deliveries under his supervision are less than 50 tons per diem. It is evident that in either case the cost will be slightly higher than the minimum charges of regular assayers undertaking this branch of service. At first, we apprehend, the State Assayer will be a busy man. When the disappointments of hopeful shippers begin to gather in an angry cloud about his head, he will discover that the law has operated chiefly to protect the buyer against imputation of fraud, while he himself will find his reputation for competency assailed. We extend our condolence in advance to the unfortunate who shall receive the gubernatorial appointment.

FEAR of hostile intent by Mexico is repudiated by that vigorous journalist, Mr. C. W. Barron, in an interview appearing in the *Boston News Bureau*. He sees no sign of Japanese or Teutonic activity that might lead to reprisals against the United States, yet he asks, "Is there any wonder that the people of Mexico have invited support and help from Japan?" We might reply by asking what aid and comfort have the Japanese conceded to the Mexicans? Mr. Barron is clearly of the opinion that it was our duty to finance any *de facto* government that emerged from the revolutionary chaos. Without financial coddling an impecunious government could not expect to prevail against the attacks of opposing factions that distribute the loot of brigandage to their adherents. This is a plausible argument, but when linked with the notion that Japan had performed a service which the United States had evaded, the case is confused. If Mexico turned to Japan, then a community of interest would be created. This might lead to unpleasant consequences in the event of friction between the United States and Mexico. Mr. Barron bestows some not unmerited commendation upon Zapata and his followers, but Zapata openly boasts of receiving supplies from Japan, limited only by his means for making payment. At the same time Carranza has been obtaining military equipment and even machinery for the manufacture of munitions from the same source. In what respect, then, has the government of Mexico found superior friendship in the Japanese? Evidently Japan has played her game so as to win the favor of the Mexican people rather than to sustain the fortunes of a single party. She has most certainly followed a course that, in its practical working, has provoked no national animosity. The intense popularity of the Japanese among all classes in Mexico is as noteworthy as the violent hatred manifested toward American citizens and the American government. In this preference lies potential danger that cannot be overlooked. Had the relations between this country and Japan been characterized by cordiality and co-operation we might lay suspicion aside. On the contrary, there has been persistent friction, and we note with regret that the test case under the law prohibiting Japanese ownership of real estate in California has been forced to an issue at this untimely moment.

Mine Taxation

War brings new needs and new laws. War is supreme. It overthrows the social structures that stand in its way; it creates new ones, built from motives of temporary expedience that sometimes survive their usefulness and encumber the future. In nothing is this influence more likely to be seen than in means for raising revenue. No man will stop to argue over the method of taxation when his country calls for support. It is important that the conception of right methods be so well inculcated in the national mind that the instinctive thought when forced to hurried legislative action shall partake of the spontaneously correct judgment that we denominate common sense. Otherwise we may have a legacy of burdensome principles hampering our future progress. Everything and everybody will be taxed; they must be taxed for our country's good, for the protection of all that we value as Americans. We shall live at constant elbow-touch with the tax-collector. The mines will be taxed. They will be called upon to contribute as never before. The mine-owners will not seek to avoid increased taxation. No man nor corporate group of men can hesitate to offer contribution gladly when it is for protection to the normal rights of citizens. The fundamental object of government is protection to life, property, and the pursuit of happiness. Except for that it would require an overwhelming sense of humor to induce men generally to live in close association with others. Mines have always proved an embarrassment to the law-makers when it came to bases for appraisal and assessment. There is a marked dissimilarity between mining property and real-estate. A piece of land when worked becomes a farm; a mine when worked becomes a hole in the ground. The farmer, as he exhausts the potash and the nitrogen from his land, can put them back; the potash and nitrogen fixed in the tissues of his crops are worth more than in the crude fertilizer that he buys. Thus a farm becomes a site for a permanent chemical industry, utilizing the beneficent gifts of water, air, and sunshine in conjunction with substances that can profitably be added when the soil has become impoverished; but neither sun, nor air, nor water can aid in the re-growth of ore. Once removed it is gone forever, counting by the lives not of individuals, but even of nations and of races. A mine has been called "a wasting asset." That is an essential characteristic of this form of property. It possesses no value, save in the imagination and hope of its owner, until it has been developed. As soon as exploitation begins, though development continue to add to the known life of the deposit, it is being exhausted. Perhaps a wiser view of its relation to the community is to say that it is being beneficiated. The mine that is being worked is being made good for human uses; the asset disappears, so far as the mine-owner is concerned, but it becomes part of the wealth of the world. It is evident that use is the real value, that productivity is what makes it serve the needs of man. There is no such thing as intrinsic value for a concrete thing; intrinsic value is a term to express the relation between need and beneficiation, between demand and productive response, and it changes from nation to nation, and from age to age. It is a pleasure to welcome at this critical moment, when manifold schemes of taxation will be developed to meet the needs of warlike preparation, the thoughtful treatise on 'Mine Taxation in the United States,' prepared by Mr. Lewis Emanuel Young, and issued by the University of Illinois as one of its series of Studies in the Social Sciences. It is peculiarly valuable on account of its scholarly analysis of the methods in vogue in the several States of the Union. Mr. Young recognizes that mine taxation in many States has "aimed at something more than the raising of revenue for immediate public needs," to which he does not lend approval. This opens a large subject for discussion. It is important to recognize this sharp cleavage and to talk definitely toward one or the other of these opposite sides of the question. If the mine is to be set apart in an exclusive category to relieve co-ordinate and accessory industry from bearing its proportionate share of the burden of government, it is well that the matter be known and clearly defined. Industry can adjust itself even to oppression if the size of the obligation be fixed and invariable. This is so trite that it should be uttered with an apology to thoughtful men were it not that thoughtful men have not taken hold of the problem and given fixedness to the principles of mine-taxation applicable in the various States. It is rather pitiful to see what a feeble showing of quotable opinion Mr. Young has been able to bring together in his chapter on 'Suggested Methods of Taxation and Reforms.' The clearest note in the whole discussion is struck by Professor E. R. A. Seligman, who says in part: "Let us recognize the fact, once for all, that a system of property taxation * * * is unsuited to modern economic conditions as the ordinary and principal source of revenue * * *. Let us boldly face the situation and confess that while a classified property tax may constitute the only possible step in advance for those States that are still tied up by a rigid constitution, the scheme is undesirable for those which are more fortunately situated from the constitutional point of view. What then is the remedy? I have no hesitation in answering—the substitution of income for property as the basis for taxation." This is true to the Semitic ideals that hark back even to the laws of Hammurabi. It is the true ideal of socialized man, founded on good utilitarian doctrine. With that we are in agreement. If property were to be accepted as the basis, it must necessarily take into account, as well as may be, the ultimate known value of the mine, which value is ascertainable only after the depletion of the ore reserves and the extinction of the mine as an economic unit. From the property standpoint the formula for the tax-assessor is clearly stated by Mr. Young in these words: "The appraised value of the property may be taken as the capitalized value of the yearly earnings which it is estimated will result from the operation of the property at a yearly output maintained for a fixed term of years at an average profit per ton extending through-

out the whole period, and not providing for any increased output beyond what may be already in sight;" to which we would add that the term 'profit' must mean excess over cost, including depreciation and replacement of plant, besides other items that the mine-owner is likely to overlook as an essential part of the expense of his operation.

Our view inclines us to the principle of the income-tax. Any direct taxation on the real estate itself that is not in its nature a tax upon non-productivity, and therefore operative as a penalty for non-use, is fundamentally opposed to the best interests of a progressive society. The property is of no avail except through its beneficiation. The plan that stimulates to productivity robs no man. It merely takes toll of his thrift, for the protection that it throws around him. By the same token we fail to see the reasonableness of taxation upon plant that is being put to the uses of production. The plant itself is valueless except through its application in response to the needs of the people. It is the product of the plant as well as of the mine that possesses value. On this basis of taxation the ends of social justice would seem to be best ensured.

Nickel

The control of this metal has given deep concern to the Canadian government ever since the promotion of the Canadian Copper Company by S. J. Ritchie in 1886. The known supply of nickel was so limited at that time that the world's annual consumption did not exceed 2,000,000 pounds, and its future importance in the manufacture of armaments and munitions of war was but dimly understood. Notwithstanding this fact the Dominion Parliament displayed remarkable prescience of the possibilities of the industry by insisting at first upon a clause in the charter of incorporation requiring the refining of the metal in Canada. In the end what may be regarded as a gentlemen's agreement was reached, whereby it was understood that the nickel ultimately would be converted into the finished product within the confines of the Dominion, but the mandatory clause was eliminated, apparently in recognition of the fact that the process of refining as then developed was in part a guarded secret of the Orford Copper Company in this country. To have insisted rigidly upon refining at home would have crippled the enterprise at the start. Continuance of the practice of refining the Sudbury nickel in another country has been a sore point for the past three decades, and the nickel question has played a prominent part in Canadian politics. The outbreak of the War accentuated the desire to retain this metal under British control, and the announcement that the merchant submarine 'Deutschland' had secured a cargo of nickel created a still stronger sentiment against the exportation of a commodity so vital in equipment for warfare. The appointment of the Royal Ontario Nickel Commission was the outcome of the agitation. Later, the demand for control of the industry extended from Canada to the mother country. It was hoped that it could be shown that Canada possessed a monopoly of nickel. The Commission refutes this, but indicates that only under the influence of high prices can serious competition be expected. In accordance with this Canadian sentiment the International Nickel Company has voluntarily begun the construction of a refinery at Port Colborne on Lake Erie, as explained in a brief summary of the Commission's report printed on another page of this issue. The International Nickel Company is a New Jersey corporation, organized in 1912 to acquire the Canadian Copper Company, the Anglo-American Iron Company, the Orford Copper Company, together with other nickel-producing concerns in Canada and in New Caledonia. It thus constitutes, in effect, a nickel trust. The visit of Dr. Willet G. Miller, a member of the Royal Commission, to New Caledonia was largely to ascertain how formidable a competition might be expected from that source. Evidently some difference of opinion on this score exists between the officers of the nickel trust and the Canadian experts. Nevertheless, drastic action against the exportation of nickeliferous matte from Canada undoubtedly will be averted by the construction of the great refinery at Port Colborne.

Meanwhile the Imperial government has co-operated with the Dominion government in starting a new domestic nickel enterprise, the British America Nickel Corporation, which owns 17,600 acres of mineral land at Sudbury, including the Murray mine. This corporation has acquired the rights to the Hybinette process, an electrolytic method for refining nickel invented and developed successfully in Norway. The enterprise was promoted originally by Dr. F. S. Pearson, who was drowned on the 'Lusitania,' and on his death his associates obtained the aid and support of the British government. In October 1916 Mr. E. P. Mathewson was engaged as general manager, in association with Mr. W. A. Carlyle, who is one of the vice-presidents of the corporation. The association of these two men with this enterprise has evoked the keen interest of the engineering profession. A smelting and refining plant is now under construction at the Murray mine. On the other hand, the intensified development of the Cuban deposits will add to the available resources of non-Canadian nickel, the outlook for extremely large tonnages at Mayari, Moa, and Cubitas being excellent. The known deposits in the United States are of minor importance. The St. Francis mountains in south-east Missouri have long yielded small amounts of nickel in conjunction with lead, and recent discoveries in the same locality are said to promise a considerably augmented output. New deposits are also reported lately from several points in the Appalachians, which are said to bear a resemblance to the Sudbury ores. It is proper that Canada should display keen interest in a commodity that is so valuable a military asset for the British Empire, and it is equally important that earnest efforts should be made in the United States to develop every source of an independent supply of nickel for our own use.

Flotation Litigation

By T. A. RICKARD

The story of American litigation over the flotation patents is interesting and perplexing. The first contest over the validity of the Minerals Separation company's principal patent was caused by James M. Hyde, who, in August 1911, introduced the use of froth-flotation at the mill of the Butte & Superior Copper Company,[1] applying the process successfully to a zinc ore carrying a small amount of lead. On October 3, 1911, suit for infringement of patent 835,120 was brought by Minerals Separation against Mr. Hyde. The trial took place before the U. S. District Court at Butte and there, on July 28, 1913, Judge Bourquin decided that the patent was valid "in respect to all claims in issue."

It will be well to outline the nature of the patent in suit. The first claim says: "The herein-described process of concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of any oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of one per cent on the ore), agitating the mixture until the oil-coated mineral matter forms into a froth, and separating the froth from the remainder by flotation."

Claim No. 12 states: "The process of concentrating powdered ore which consists in separating the minerals from gangue by coating the minerals with oil in water containing a fraction of one per cent of oil on the ore, agitating the mixture to cause the oil-coated mineral to form a froth, and separating the froth from the remainder of the mixture."

The patentees—H. L. Sulman, H. F. K. Picard, and John Ballot—refer in their specification to the Cattermole patent, No. 777,273, in which mention is made of using "an amount of oil varying from four per cent to six per cent of the weight of metalliferous matter present," and they then proceed to explain:

"We have found that if the proportion of oily substance be considerably reduced—say, to a fraction of one per cent on the ore—granulation ceases to take place, and after vigorous agitation there is a tendency for a part of the oil-coated metalliferous matter to rise to the surface of the pulp in the form of a froth or scum. This tendency is dependent on a number of factors. Thus the water in which the oiling is effected is preferably slightly acidified by adding, say, a fraction of one per cent up to one per cent of sulphuric acid or other mineral acid or acid salt; the effect of this acidity being to prevent gangue from being coated with oily substance, or, in other words, to render the selective action of the oil more marked; but it is to be understood that the object of using acid in the pulp according to this invention is not to bring about the generation of gas for the purpose of flotation thereby, and the proportion of acid is insufficient to cause chemical action on the metalliferous minerals present. Again, we have discovered that the tendency for the oily substance to disseminate through the pulp and the rapidity with which the metalliferous matter becomes coated is increased if the pulp is warmed. The formation of froth is assisted by the fine pulverization of the ore, and we find that slime mineral most readily generates scum and rises to the surface, while larger particles have less tendency to be included in the froth."

Application for this patent was filed on May 29, 1905, and the rights accruing under the patent start from this date. The patent was granted on November 6, 1906, and the life of the patent, 17 years, is measured from this later date.

Judge Bourquin's decision was sweeping.[2] It rested largely on a reply to the question whether Froment's British patent No. 12,778, of June 4, 1902, anticipated the patent in suit. On this point the Court expressed itself as follows:

"Froment's [patent] requires several times the quantity of oil that does this in suit, both by examination of the patents and working description and by tests in evidence. Froment crushes the ore in two operations, and deslimes it before treatment, because the slime is too fine to be treated by his process, while the process in suit needs but one crushing operation, and finds slime advantageous and most easily recovered. Froment employs carbonate of lime; the process in suit does not. Froment requires acid, and in greater quantity and for a different function than does the process in suit, which latter may or may not use acid. Both may use heat, and both require agitation—Froment agitation only to disseminate the oil, the process in suit for that purpose and also to aerate. Froment's result is by flotation by gas generated *in situ;* this in suit is by flotation by air introduced by vigorous agitation. Froment's product is like unto a magma, a spongy, pasty mass of oil and metallic particles, and more or less gas bubbles, while this in suit is a froth of oil and metallic particles and air-bubbles. Froment's requires oil in such quantity that he deems it worthy of recovery from the concentrate, so far as it can be; this in suit so little oil it disappears, is not sensible to sight or touch upon the concentrate but only to analysis. In Froment's it would seem that the metallic particles are floated like the bas-

[1]This company did not produce copper, but zinc, lead, and silver. In 1916 the name was changed to Butte & Superior Mining Company.

[2]For full text of this decision see M. & S. P., August 16, 1913.

ket of a balloon, while in this like the very envelope of a balloon. Froment's is costly, while this is cheap. And from the evidence it would seem that Froment's process would fail in practical operation, while this in suit has succeeded. In Froment's he oils the metallic particles by agitation; then, when the mixture is quiescent, generates gas therein by quick reaction, followed by immediate and direct rising of the gas bubbles to the surface in which they may come into contact with but few metallic particles. In this in suit vigorous agitation of the mixture beats great and excess volumes of air therein, likely bringing the ultimate air bubbles into repeated contact with many metallic particles. The action of the gas in Froment's is almost explosive in nature. He speaks of proportion of carbonate of lime to be sought as, in his test-tube example, the reaction may be so sudden and violent as to project the metallic particles out of the tube. Froment's gas bubbles, quick formed and quick rising it may be, arrive at the surface with expansion still in progress. These or analogous reasons may account for Froment's magma breaking gas bubbles and fragile evanescent froth in so far as his result is like unto froth, and also may account for the process in suit's strong and lasting froth."

On appeal to the Ninth Circuit in San Francisco the decision of the lower court was reversed, on May 4, 1914. The opinion of the Court of Appeals, pronounced by Judge Gilbert, stated that "the fact that the appellees use a smaller quantity of oil than was used in the prior art is not of itself, and is not claimed by them to be, sufficient to distinguish their process so as to render it patentable." This Court held that "the agitating of the mixture to cause the oily-coated mineral to form a froth" was "clearly anticipated by the prior art." It is noteworthy that the Examiner of Patents rejected claim No. 12 "in view of 763,260, Cattermole, June 21, 1904; or 793,808, Sulman et al, July 4, 1905, . . . as expressing merely a difference of degree thereover as to the proportion of oily matter employed." Thus the Examiner refused to allow patentability on the mere use of a small percentage of oil. The claim thus cancelled, not the No. 12 of the final patent, quoted above, was the only one that was based exclusively on the use of a fraction of 1% of oil, withous reference to a particular kind of agitation or a particular kind of froth. The Appellate Court took cognizance of this interesting disclosure, for Judge Gilbert said:[3]

"We hold that to sustain the appellees' patent would be to give to the owners thereof a monopoly of that which others had discovered. What they claim to be the new and useful feature of their invention, as stated by their counsel, is 'agitating the mixture to cause the oily-coated mineral to form a froth.' As we have seen, that feature was clearly anticipated by the prior art, and when the elements of the appellees' claims are read one by one it will be found that each step in their process is fully described in more than one of the patents of the prior art, with the single exception of the reduced quantity of oil which they use. The patentees of the appellees' patent made a valuable contribution to the art in discovering the smallest quantity of oil which would produce the desired result. In doing so they pursued the course which all skilful metallurgists would be expected to pursue. They made a series of experiments to determine how small a quantity of oil could be used successfully. They found, as all must find who apply the oil flotation process, that certain oils are adapted to use with certain ores, and that a larger quantity of oil is necessary for one kind of ore than for another. The appellees admit that for some ores they use four times as much oil as for others. Their discovery that a small fraction of one per cent of oil is sufficient to produce flotation of the metalliferous matter cannot, as we have seen, be made by itself or in a combination the subject of a patent. The appellees cannot take from others the right to use oil economically. This was evidently the ruling of the Patent Office on their application for a patent. One of their claims in the original application was 'the process of concentrating powdered ore, which consists in separating minerals from gangue by coating the minerals with oil in water containing a fraction of one per cent of oil on the ore, and recovering the oil-coated minerals.' This was rejected in view of the Cattermole patent 'as expressing merely a difference of degree thereover as to the proportion of oily matter employed.' Counsel for appellees admit that the claim was properly rejected for the reason that it leaves out the agitation and froth, and say 'our invention is something else than the mere reduction of oil'."

Thereupon Minerals Separation obtained a hearing before the Supreme Court of the United States on a writ of certiorari. The case was argued in October 1916. The court expressed its opinion through Mr. Justice Clark on December 11, 1916. It was laid down that the patent was valid on three counts, (1) the use of a 'critical' and minute proportion of oil, (2) the use of a particular kind of agitation, namely "by beating air into the mass," and (3) the production of a "peculiarly coherent and persistent" kind of froth. The most important parts of the opinion are to be found in three paragraphs.[4] The first defines the patent:

"The process of the patent in suit, as described and practiced, consists in the use of an amount of oil which is 'critical,' and minute as compared with the amount used in prior processes 'amounting to a fraction of one per cent on the ore,' and in so impregnating with air the mass of ore and water used, by agitation—'by beating air into the mass'—as to cause to rise to the surface of the mass, or pulp, a froth, peculiarly coherent and persistent in character, which is composed of air bubbles with only a trace of oil in them, which carry in mechanical suspension a very high percentage of the metal and metalliferous particles of ore which were contained in the mass of crushed ore subjected to treatment. This froth can be removed and the metal recovered by processes with which the patent is not concerned."

[3]For the full text of this decision see M. & S. P., May 9, 1914.

[4]For full text see M. & S. P., December 30, 1916.

"It is obvious that the process of the patent in suit, as we have described it, is not of the Metal Sinking class, and while it may, in terms, be described as a Surface Flotation process, yet it differs so essentially from all prior processes in its character, in its simplicity of operation and in the resulting concentration, that we are persuaded that it constitutes a new and patentable discovery."

The third declares the validity of the patent, but restricts its application.

"While we thus find in favor of the validity of the patent, we cannot agree with the District Court in regarding it valid as to all of the claims in suit. As we have pointed out in this opinion there were many investigators at work in this field to which the process in suit relates when the patentees came into it, and it was while engaged in study of prior kindred processes that their discovery was made. While the evidence in the case makes it clear that they discovered the final step which converted experiment into solution, 'turned failure into success' (*The Barbed Wire Patent*, 143 U. S. 275), yet the investigations preceding were so informing that this final step was not a long one and the patent must be confined to the results obtained by the use of oil within the proportions often described in the testimony and in the claims of the patent as 'critical proportions' 'amounting to a fraction of one per cent on the ore,' and therefore the decree of this court will be that the patent is valid as to claims No. 1, 2, 3, 5, 6, 7, and 12, and that the defendant infringed these claims, but that it is invalid as to claims 9, 10, and 11. Claims No. 4, 8, and 13 were not considered in the decree of the two lower courts and are not in issue in this proceeding."

Meanwhile a number of Western mining companies had begun to use flotation. One of them was the Miami Copper Company, in Arizona. On October 10, 1914, suit was brought by Minerals Separation for infringement of patent No. 835,120 and also of No. 962,678 and 1,099,699. The first trial took place in the District Court at Wilmington, Delaware, and the decision, by Judge Bradford, was pronounced on September 30, 1916.[5]

In this case the issue differed from that involved in the previous litigation. Hyde had denied, not infringement, but the validity of patent 835,120. The Miami company denied infringement, claiming that it was using a method similar to that described in a patent of earlier date, namely No. 793,808. Judge Bradford accepted this contention. He said:

"The evidence shows that the defendant in its concentration of ore in its pneumatic flotation plant employs the process of patent No. 793,808, of July 4, 1905, to Sulman & Picard, hereinbefore discussed, as modified by the use of certain apparatus substantially the same as a portion of the apparatus, the operation of which is described in the above-mentioned Callow patent," namely, No. 1,104,755 of July 21, 1914, to John M. Callow. He decided that the Froment patent was not an anticipation because "it does not appear that there was present in the Froment process the very minute quantity of oil of the first patent in suit."

The essential part of the Wilmington decision is that the diminution of oil to less than 1% of the weight of the ore is patentable. Judge Bradford said:

"On the whole I am satisfied that the first patent in suit must be sustained as to claims 1 and 12, but not as to claim 9. The two former are definite, specifying and limiting the amount of oil to be used; claim 1 mentioning 'a small proportion * * * amounting to a fraction of one per cent on the ore,' and claim 12 'a fraction of one per cent of oil on the ore.' Claim 9 mentions 'a small quantity of oil.' This is so indefinite as to render the claim void, unless on consideration of the patent as a whole the claim can by construction be limited to the use of oil amounting to only a fraction of one per cent. The patentability of the process of the first patent in suit resides in the use of oil in the extremely minute proportion disclosed in the descriptive portion of the patent to effect separation of froth with its metallic particles from the remainder of the mixture by flotation. The amount there disclosed is not in excess of 'a fraction of one per cent on the ore' and may be only one-tenth of one per cent on the ore, or even less. If, then, by construction claim 9 should be so limited as to be restricted to the use of oil amounting to only a fraction of one per cent on the ore, that claim is in substance, though not in exact phraseology, the same as claim 1 for the reason that in any event from the nature of the invention it would be necessary to read 'by flotation' into claim 9, if in other respects valid. But a limitation by construction producing such a result is inadmissible. It is suggested by one of the plaintiff's counsel in his consideration of claim 9, that one for the purpose of securing immunity from the consequences of infringement might use an oil useful in the process, and add to it an oil not useful as applied to his particular ore, and, on being sued for infringement contend, 'I am using 1.1% of oil. I do not infringe. I am using more than a fraction of 1% of oil.' But the existence of this possibility does not, I think, warrant such a construction of claim 9 as is urged; for the disclosure of the patent does not extend to the use of 1.1% of oil, but is limited to a fraction of 1%."

In regard to the second patent in suit, No. 962,678, of June 28, 1910, to Sulman, Greenway, and Higgins, the Court quotes part of the description in the patent:

"According to this invention the crushed ore is mixed with water containing in solution a small percentage of a mineral-frothing agent (that is of one or more organic substances which enable metallic sulphides to float under conditions hereinafter specified) and containing also a small percentage of a suitable acid such as sulphuric acid, and the mixture is thoroughly agitated; a gas is liberated in, generated in, or effectively introduced into the mixture and the ore particles come in contact with the gas and the result is that metallic sulphide particles

[5]For full text of this decision see M. & S. P., October 14 and 21, 1916.

float to the surface in the form of a froth or scum, and can thereafter be separated by any well-known means. Among the organic substances which in solution we have found suitable for use as mineral-frothing agents with certain ores are amyl acetate and other esters; phenol and its homologues; benzoic, valerianic, and lactic acids; acetones and other ketones such as camphor. In some cases a mixture of two such mineral-frothing agents gives a better result than a single agent. * * * The present process differs from the two before mentioned types and from other known concentration processes by the introduction into the acidified ore pulp of a small quantity of a mineral-frothing agent, that is, an organic compound in solution of the kind above referred to and by the fact that the metalliferous particles are brought to the surface in the form of a froth or scum not by mechanical means but by the attachment of air or other gas bubbles thereto. In the frothing process hitherto known the substance used to secure the formation of a mineral-bearing froth has been oil or an oily liquid immiscible with water. According to this invention the mineral-frothing agent consists of an organic compound contained in solution in the acidified water."

The Court then proceeds to say:

"It will be observed that no one of the claims of the second patent in suit requires as an element an oily substance or liquid, as is essential in the process of the first patent in suit, and all of the claims relied on require the introduction into the mixture of 'a small quantity' of a 'mineral frothing agent' or an 'organic mineral frothing agent.' The amount of the mineral frothing agent employed in the process is not confined to a fraction of one per cent on the ore, but must be a small quantity, evidently to be determined by the metallurgical engineer conducting or superintending the operation according to the requirements of the different ores. The novelty of this invention is to be found, not in any restriction of the amount of the mineral frothing agent to any stated proportion, for there is none, but in the fact that a mineral frothing agent as the means of separating the metallic particles from the gangue is substituted for the oil, fatty acid, or other oily substance essential to the process of the first patent in suit. Such substitution has produced successful results, and, I think, involved invention. Frothing agents had theretofore been used in ore concentration, but not in the absence of an oily ingredient. Even were the grounds on which the validity of the patent can be sustained less clear, it should have the benefit of the presumption of validity arising from the grant of letters. That the defendant has infringed the claims in suit of the second patent is established by the evidence."

The third patent, No. 1,099,699, was not sustained and need not be discussed.

The most remarkable feature of Judge Bradford's opinion is that he states flatly that the Miami is using the process of patent 793,808 yet he holds that the company has infringed patent 835,120, the numbers of these patents indicating their relative age.

An analysis of the decisions up to date shows that three courts out of four have sustained the validity of patent 835,120 but the reasons have been dissimilar and even contradictory. For the sake of brevity, I shall refer to the courts by the cities in which the issue was tried.

Butte said that Froment did not anticipate Sulman et al.

San Francisco said that he, and others, did do so. This court refused to consider the mere diminution in the proportion of oil as a subject for patent.

The Examiner of Patents had decided likewise.

Washington granted validity on account of limitation of oil, peculiar agitation, and peculiar froth. This court decided that Froment's process "was little more than a laboratory experiment" and did not anticipate the workable process described in 835,120.

Wilmington granted validity on account of the specification of critical proportion of oil, and adversed the one claim that did not specify that limitation.

Moreover, the Supreme Court differs with everyone that has passed on patent 835,120. It holds the Patent Office wrong for having granted indefinite claims, it holds the Butte court wrong in deciding that such indefinite claims were valid, it holds the San Francisco court wrong for invalidating the whole patent, by inference it holds the Wilmington court wrong for basing patentability on a small proportion of oil alone.

It is a curious fact that the practicability of producing an effective froth by means of more than 1% of oil was not tried on a working scale before these suits were started. Such experimental demonstrations as were made, out of court or before the judges, were apparently unconvincing, for the sufficient reason, I believe, that the minimum proportion was considered best even by the defendants, but as soon as the Supreme Court had given its opinion and placed so much emphasis on the 'critical' proportion, the use of more than 1% of oil was applied successfully on a scale of over 1000 tons per day in the mills of the Utah Copper and Butte & Superior companies, in Utah and Montana, respectively. The 'critical' point was proved fallacious early in 1917.

An appeal from the Wilmington decision was taken promptly by the Miami company to the Court of Appeals for the Third Circuit, at Philadelphia, where the case was heard in February 1917. As was to have been anticipated, the appellees made the most of the Supreme Court's decision in the Hyde case, in so far as it defined and limited the scope of patent 835,120. Counsel argued that the Miami had not infringed because its metallurgical operations differed radically from those described in the Supreme Court's decision, both in the kind of aeration employed and in the character of the froth produced. Whereas Hyde, and Minerals Separation, used mechanical means for causing violent agitation and producing the 'cauliflower' froth, as Mr. Ballot had termed it, they, the Miami company, used a Callow cell, an inclined trough having a porous bottom through which compressed air at a low pressure was admitted, producing a froth without the aid of mechanical agitation, and the froth thus formed was described as thin,

tender, and evanescent. This froth broke and disappeared as soon as the supply of air was withdrawn, while the froth produced by beating air into the pulp would last for days. While the Miami used less than 1% of oil, it did not employ the two other elements essential to patent 835,120, namely the violent mechanical agitation and the formation of a peculiarly coherent and persistent froth. It was argued that a patent claim for a combination of any three elements, such as those specified by the Supreme Court in patent 835,120, created a monopoly only in the use of a process in which all three of the stated elements were used. No monopoly was secured of any one of the elements used singly and apart from the others. Therefore, there was nothing in the Supreme Court's decision giving Minerals Separation a monopoly of the use of a fraction of oil *per se;* on the contrary, the Supreme Court stated that the patent derived its validity from the three factors taken together. So the Miami company contended that it had a perfect right to use any quantity of oil, however minute, provided it used the oil in a process that did not include the violent agitation and the persistent froth characteristic of the Minerals Separation process. Whereupon the patentees had to repudiate the limitations specified by the Supreme Court and depart from the contention that they had made in the Hyde case concerning the special and remarkable character of the froth produced by their process. In the District Court the great difference between the two kinds of froth, one due to beating air into the pulp during violent mixing and the other to the simple introduction of compressed air through a porous bottom, had been emphasized heavily and the statement had been repeated that a shovel had been seen to rest on the froth of patent 835,120, whereas even a match would sink through the kind of froth made at Miami. In the appeal at Philadelphia another tack had to be taken, so counsel for Minerals Separation, in their reply brief, stated:

"With respect to the character of the froth, there can be no serious contention. Before the discovery of these patentees nothing in the nature of froth (a collection of bubbles on the surface) remained long enough to permit recovery of the metal. By reason of the discovery of these patentees a froth was produced, composed of 'modified' air bubbles, coherent and persistent enough to permit of recovery of the metal. That was the unique thing —the peculiarity adverted to by the Supreme Court. In defendant's practice the froth produced by it is similarly composed of 'modified' air bubbles, and so is coherent and persistent enough to permit of recovery of the metal. There is no point and nothing of importance in the degree of coherency or persistency beyond and in excess of that required for the recovery of the valuable metal."

Some reference to the previous litigation in England and Australia may be made, although it is now only of secondary importance. It is vital to the proper understanding of the patent litigation as a whole to recognize the fact that the decisions in the British and Australian cases did not establish the validity of the British equivalent of U. S. patent 835,120. That issue was not before those courts; indeed, the prior art, except as it had a bearing on the validity of the Elmore bulk-oil patents, was not under consideration. Moreover, it was the Elmore bulk-oil patent of 1898 and not the vacuum-air patent of 1904 that was at stake. The question before the British and Australian courts was the validity of Frank Elmore's British patent No. 21,948 of 1898 and Stanley Elmore's British patent No. 6519 of 1901, the first the principal bulk-oil patent and the second a modification specifying the use of acid. No account was taken of the patents issued between the dates of these Elmore patents and the date of the Minerals Separation patent of 1905, nor was the question of how such intervening patents would affect the validity of 835,120 considered. To establish the fact that Elmore's bulk-oil patent is not valid or that the M. S. process is not the Elmore process does not prove anything with regard to the validity of the M. S. patent. That question was not before the British courts and it is remarkable therefore that these cases should have been cited at all in the American courts. The effect of the citation has been only confusing.

Most of the English suits were between Minerals Separation and the Elmores, or the company with which they were identified. Personal quarrels and charges of bad faith were made in Sulman & Picard *v.* Wolf, in 1905, and in Ore Concentration Company [Elmores] *v.* Webster and others [the Minerals Separation group] in 1908, but the two cases involving basic patent-rights were both brought by the Elmores against Minerals Separation.

In the first case, ended in 1909, British Ore Concentration Syndicate Ltd. and Alexander Stanley Elmore *v.* Minerals Separation, Ltd., the principal issue was the validity of the Elmore bulk-oil patents of 1898 and 1901 against the Minerals Separation process as described in British patent No. 7803, the equivalent of U. S. 835,120. The Court (Mr. Justice Neville) gave judgment against the Elmores and decided that:

(1) The selective action of oil for sulphides was known before Elmore obtained his patents, and was disclosed in prior expired patents.

(2) Elmore's patent was for a process wherein a large quantity of oil was used, sufficient to carry all the sulphides to the surface by the buoyancy of the oil.

(3) The Minerals Separation process used only an infinitesimal amount of oil for the purpose of attaching air-bubbles to the sulphides, causing them to float by the buoyancy of the air-bubbles, and did not infringe F. E. Elmore's patent.

(4) The use of acid in oil processes was known before A. S. Elmore obtained his patents and was disclosed in prior expired patents, therefore, Elmore's patent was not infringed by Minerals Separation.

The plaintiff appealed and the decison of the court was reversed, it being held that Minerals Separation was infringing the 1901 patent, involving the use of acid with oil. The Court of Appeal found that

(1) The first Elmore patent was not anticipated by previous expired patents [such as those of Robson and Everson].

(2) If Minerals Separation used a thin oil they would not infringe Elmore [who used a thick oil; so also Minerals Separation used a thicker oil (oleic acid) than is now customary in the United States].

(3) The second Elmore patent [that of A. S. Elmore of 1901] was not anticipated by previous expired patents [such as Everson's, in which acidulation is mentioned].

(4) Minerals Separation infringed the second patent by using acid.

An appeal was then taken to the House of Lords and on November 16, 1909, the judgment of the Court of Appeals was reversed, that of the trial court being upheld.

The Lord Chancellor (the Earl of Loreburn) said that the Frank Elmore patent of 1898 need not be discussed, because it had no place in the controversy, "into which it has nevertheless been introduced with no other result than to confuse the issue." He held that the Stanley Elmore patent of 1901 was "framed with great subtlety, being partly narrative, partly claim" and "designed in order that the claim might be expanded or contracted as occasion might require in the interest of the patentee"; that the only definite claim was for acidulation, and that this claim was anticipated by Everson; therefore the patent could not be sustained.

The Earl of Halsbury was of the opinion that the inventions of Elmore and Minerals Separation were "essentially different," the one being dependent on "the selective action of oil, the other upon surface tension"; that acidulation had been "invented and patented" before the date of Stanley Elmore's patent, and that this patent was so ambiguously stated that it should be held bad.

Lord Atkinson likewise described the specification of the patent as "framed, somewhat craftily, in terms of studied vagueness and ambiguity"; he held that it could not claim "the mere addition of acid in small quantities to a mixture of ore, water, and a relatively infinitesimal quantity of oil reduced to a 'freely flowing pulp'." If the patent was for the addition of a small quantity of acid and a relatively large quantity of oil to a mixture of ore and water, where the oil, in accordance with some obscure law of affinity, seized upon the minute particles of ore in preference to the earthy particles, and, by the buoyancy of oil, floated them to the surface, then the Minerals Separation did not infringe this process, because their process was one where they made use of the known selective action of oil, yet the oil was used in relatively small quantities, and the metallic particles were only coated with a thin film of it, and the lifting force was found, not in the buoyancy of the oil, but in the natural buoyancy of the air-bubbles, which, introduced into the mass by violent agitation, envelop or become attached to the oiled mineral particles and raise them to the surface.

Lord Shaw of Dunfermline said: "It has already been determined that the use of thin oil instead of thick imports no infringement of the 1898 patent, nor do I see my way to hold that there has been any contravention of the 1901 patent by the application of the acid to a mixture in which the oil has been reduced from bulk to the merest fraction, and especially when froth instead of oil has been secured, along with the law of capillarity or surface tension, as the main floating and separating agent." He held that the processes were essentially different and that there was no infringement.

Lord Ashbourne concurred with the decision of their lordships, thus making the judgment of the Court unanimous.

Meanwhile, in 1910, the Elmores had brought suit against the Sulphide Corporation, a licensee of Minerals Separation, operating at Broken Hill. The issue was tried in Australia with a result adverse to the Elmores, who then appealed to the Judicial Committee of the Privy Council, which heard the case in November 1913 and gave a decision on March 6, 1914. This decision confirmed the lower court and was in accord with that of the House of Lords; the Judicial Committee found that the Everson patent did not anticipate the Elmore acid-oil patent, but, on the other hand, that the Minerals Separation process was not an infringement of the Elmore patent, because it relied on surface-tension, and not oil, for the flotation effect.

I quote two of the decisive paragraphs in this decision of the Privy Council:

"The Appellants place considerable importance on the second form of apparatus described in the patent. In this apparatus a thin stream of oil is thoroughly mixed with the pulp, and the oil 'by its selective action coats or absorbs the metallic particles, sulphides, tellurides, and the like.' The whole mixture then flows over a weir and down an incline over a number of wave-like steps or baffles by which the stream of pulp and oil globules is thrown against an oiled apron continuously moving in the opposite direction. Separation is effected by the oiled surface of the apron taking up most of the oil globules and by also picking up from the pulp such particles of metallic substances as have escaped oil selection in the mixer. The patentee distinctly draws attention to the fact that separation in this apparatus does not depend upon the buoyancy of the oil, and that consequently tar, heavy residuum oils, and other like substances of a greater gravity than water may be employed as the selective agent. The question arises whether the selective action of the oil or tar when the separation is effected by the second apparatus differs from the selective action of oil when the separation is effected in the first apparatus. The answer is in the negative. The 'coating or absorbing' described in connection with the second apparatus is not different in character from the entrapping described in the first apparatus. The 'oil globules' hold and carry the metallic particles and are taken up by the oiled surface of the apron, which also picks up from the pulp such particles of metallic substances as have escaped selection by the oil in the mixer,

that is to say, such particles as have not been coated and carried in the 'oil globules.'

"Apart from any question of theory, the Respondents use oil in their process under conditions which make it almost impossible to entrap or coat and hold the metallic particles by the selective agency of oil. The Respondents use a thin oil at a temperature of 120°F., the quantity is minute, not more than 2 or 3 pounds to a ton of ore, or about 2 or 3 pints of oil to 10,000 pints of water; the resulting concentrate is practically free from oil, and no mechanical contrivance to separate the oil from the metallic particles is required or used; the residue of the first concentration is further treated without any further addition of oil. There is no doubt a difference in the views of the respective experts whose standing and experience entitle them to great weight and authority, but in deciding between these views their Lordships accept the evidence of Professor Pollock to be found in questions 5780 and the following questions. This evidence may be summarized as follows: Professor Pollock is referred to his earlier evidence, and states that he does not think that the small quantity of oil introduced in the defendants' process necessarily performs any other function than permanency in the froth and extremely minute emulsion. He allows that there may be oil in excess, and that some of the particles may get oiled, but states that this is entirely and absolutely unessential. He does not, however, think that more than the necessary quantity of oil is introduced to effect concentration, but that having regard to the nature of the problem it is a matter of conjecture, and exact calculation is not possible. Fnnally, he reiterates his opinion that the defendants' process can be accounted for without assuming selection of the metallic particles by oil. Applying this evidence, their Lordships find that the Respondents do not either directly or indirectly use the invention claimed by the Appellants, but a process essentially distinct, and that there is no infringement."

Throughout these British and Australian litigations the validity of the bulk-oil patents, of 1898 and 1901, and not of the vacuum patent, of 1904, was at stake. It is a curious fact that whereas the Elmore vacuum method depends upon surface-tension and the use of air quite as much as the Minerals Separation method, it was not cited in the litigation and it was ignored by the courts. It is also curious that during the six years of litigation in the United States the Elmore vacuum patent was not used to attack the validity of 835,120, although this patent of Minerals Separation was taken out in England on April 12, 1905, as compared with Elmore's vacuum patent of August 16, 1904. It may be asked, why did not the Miami company fall back on this defence and use Elmore to fight the Minerals Separation? The answer is the fear to establish another patent monopoly, possibly no more pleasant than the one already on the ground. However, in May 1915, after the Miami suit had been heard at Wilmington, the Elmore vacuum patents were purchased for $50,000 by a syndicate headed by Messrs. D. C. Jackling and J. Parke Channing, representing the Utah, Miami, and other important copper-mining companies in the United States. It is possible that the possession of these Elmore patents may prove an interesting factor in later litigation, but it is more likely that the use of oil will be discarded before the litigation is ended.

The decision of the Court of Appeals at Philadelphia is expected at any moment. Meanwhile it is to be noted that after Minerals Separation won the preliminary decision in the Hyde case at Butte they brought suit against the Butte & Superior company and moved for a preliminary injunction. This was in the autumn of 1913. The Butte & Superior case was brought before the same court as that in which the Hyde case was first tried, and this court, at Butte, ruled that no injunction would be issued if the Butte & Superior company would file a bond and also file monthly reports of its flotation operations with the Clerk of the Court. This condition was fulfilled. No injunction was issued and the case has rested in *statu quo* up to the present. The trial begins on April 16.

Volatilization Method for Lead Ores

At the metallurgical research branch of the Utah station of the Bureau of Mines, A. E. Wells has obtained interesting results in experiments on low-grade lead ores which had failed to respond to treatment by flotation or leaching. Mixing these ores with sodium chloride, and heating to temperatures of about 800°C., high extractions of lead were obtained, irrespective of the character of the gangue. The lead volatilizes as a chloride, and the silver and gold also volatilize. The volatile products are precipitated from the fume by the Cottrell precipitator. The precipitated lead chloride, after admixture with lime and a reducing agent, is heated to redness, when the metallic lead settles out, and a slag of calcium chloride is formed. Calcium chloride is suitable as a substitute for the sodium chloride in the first operation. From 50 to 75% of the chlorine is recovered in this manner. The process offers the advantage of producing lead bullion from either oxide or sulphide ores in places where water is insufficient for milling purposes.

WHEN BARRING DOWN, especially in a stope where there is a lot of bar work to be done, it is a good idea to first see that the floor is good and clean. See that there are no tools or loose lagging to trip and fall over. One may have to make a quick jump backward or sideways to avoid a falling rock, for no one can tell which way a rock is going to bounce when it hits a cap or girt. Watch the bar, for it is surprising the way a rock will slide down a bar and give the holder a cut or bruise. Never stand behind a man using a bar, but if possible stand where it is possible to watch the ground and observe a seam or crack opening up that he failed to see. Try to avoid barring over a cap or girt, for a rock may strike the end of the bar and a broken arm or jawbone may be the result.—*The Anode.*

Tank Earthwork

By H. N. HERRICK

The formulas on the opposite page are for use in calculating the quantities of earth-work involved in the preparation of sites for large steel tanks. By the use of these formulas, all calculations may be made directly in the field-book used in setting grade-stakes, without drafting-instruments or planimeter. This is of special advantage when several sites are to be compared in the field to determine which will require the least grading.

Special formulas are given for grades 125 feet in diameter, usually used for 55,000-bbl. oil-tanks of 114 ft. 6 in. diameter, and for grades 105 ft. diam. adapted to the 37,500-bbl. tanks in common use in the oil business. A general formula is given for smaller grades. While the calculation appears rather complicated at first glance, its simplicity will be apparent on comparing the example worked out for a 125-ft. grade with a similar computation by some of the other common methods.

The derivation of these formulas is too tedious to be given in detail, but it may be outlined as follows:

(1) The cylindrical figure whose horizontal projection is the base of the grade is made up of a number of prisms, the areas of whose horizontal bases are known from the conditions assumed, and whose vertical edges are the 'cuts.' The volumes of these prisms are calculated, the cuts being represented by the letters shown on the diagram, added together, and reduced to cubic yards.

(2) The ring, of varying triangular section, outside of the cylinder, is treated as follows: The area of the triangular section at each 30° line is expressed in terms of the cut at the edge of the base and the elevation of the slope-stake (set where the excavation meets the natural surface), the slope of the bank being given. The distance from the centre of the grade to the centre of gravity of this triangular area is found in terms of the same quantities and the radius of the grade, and the volume generated by swinging the triangle through 30° calculated according to Guldin's principle. The volumes thus found are added together, reduced to cubic yards, and added to the volume found in (1).

The formulas apply equally well to a grade that is to be made entirely in fill, by substituting "fill" for "cut" throughout. Tank-grades should never be built in both cut and fill, for obvious reasons.

Flotation at the Suan Concession

In December last the total concentrate recovered in the Suan mill of the Seoul Mining Co. in Korea had a value of $20,791, of which $16,975 was recovered by flotation. The ore presents unique features that call for a high degree of technical skill in treatment. The gold is associated with copper sulphides, the sulph-arsenide (mispickel) and arsenides of iron. The flotation plant takes the tailing from the table-concentrators. During the month the flotation plant was in operation 94.4% of the total time, and treated 4425 tons of pulp averaging 1.85 dwt. gold and 0.70% copper. The tailing from the flotation cells assayed 1.07 dwt. gold per ton and 0.08% copper, while the grade of the concentrate was maintained at 34.25 dwt. gold and 26.41% copper. The recovery effected by flotation alone, based on the assay-value of the concentrator-tailing treated, was 89.1% of the copper and 43.8% of the gold. The latter points to the difficulty experienced in floating the arsenides, which are in a state of excessively fine comminution. Furthermore, the arsenides respond less kindly to flotation. The pulp sent to the flotation-cells contains only 9.5% coarser than 100-mesh. It is diluted in the ratio of 3.3 water to 1 of solid matter. The flotation reagents used in the treatment of this pulp were:

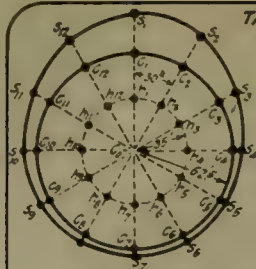
Camphor oil	0.03 lb. per ton of ore
Eucalyptus oil	0.46 " " " " "
Coal-tar	0.324 " " " " "

Lime is found essential and is employed at the rate of 2.82 lb. per ton of ore. The function of the lime is to produce flocculation of the slime, which in this case has proved a necessary condition for success. On the ore from the neighboring Tul Mi Chung, belonging to the same company, the use of lime is prohibitory, and caustic soda, a deflocculent, is used in the proportion of 2.49 lb. per ton of ore, combined with 0.49 lb. eucalyptus oil and 0.01 lb. red engine-oil as floatative agents. The caustic soda also performs the function of a floatative assistant in this case. Carbonate of soda (soda-ash) would normally be preferred on account of its cheapness, but under existing war conditions the output of the soda-ash factories in the United States and England is under contract more than a year ahead. Caustic is produced electrically at a few plants, and is more readily available. At the Suan mill careful tests have been made to determine the relative efficiency of beating in air by agitation with a Minerals Separation machine and introducing compressed air in a Callow apparatus. Contrary to the experience in some of the largest copper-concentrating plants in the United States, mechanical agitation has proved advantageous, as revealed by parallel tests extending over a month, as shown by the averages for the period, given in the table below.

	Heads		Concentrate		Tailing		Recovery	
	Gold, Dwt.	Copper, %	Gold, Dwt.	Copper, %	Gold, Dwt.	Copper, %	Gold, Dwt.	Copper, %
Air	1.6	0.59	12.7	13.2	1.3	0.10	18.75	83.05
Mechanical	1.8	0.64	20.8	13.9	1.1	0.07	47.6	89.05

The foregoing figures represent the actual recovery obtained from the pulp passing through the primary flotation-cells. The final high-grade concentrate is the result of treatment of the primary-froth in cleaner cells, in which mechanical agitation also is employed. A mat-

TANK GRADE 125' DIAMETER FOR 55 000-BBL. TANK



Find in field:
Cut at center, = C_o (ft.)
Cuts at circumference, 30° apart, = C_1 C_2 ··· C_{12} (ft.)
Cuts at 35 ft. radius, 30° apart, = h_1 · h_2 ··· h_{12} (ft.)
Elevations of slope stakes, s_1 · s_2 ··· s_{12} (ft.) above grade.

Side slope $1\frac{1}{2}$:1

Volume, Cubic Yards:

$$V = 47.4\,C_o + 20.92\,[h_1+h_2+h_3+\cdots h_{12}] + 13\,[C_1+C_2+C_3+\cdots C_{12}]$$
$$+ 0.909\,[C_1s_1+C_2s_2+C_3s_3+\cdots C_{12}s_{12}]$$
$$+ .007272\,[C_1s_1^2+C_2s_2^2+C_3s_3^2+\cdots C_{12}s_{12}^2]$$

Or, Vol. of excavation in Cu. Yds. equals –
47.4 times center cut + 20.92 times sum of cuts on 35 ft. radius + 13 times sum of cuts at 62.5 ft. radius + .909 times sum of products of each cut at 62.5 ft. by its corresponding slope stake elev. + .007272 times the sum of the products of each cut at 62.5 ft. by the square of its corresponding slope stake elev.

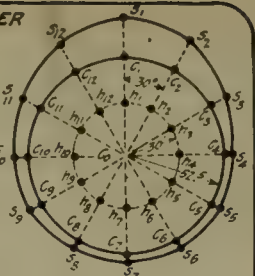
The calculation may be most simply made in tabular form, by adding two columns, for Cs and Cs^2, to the ordinary field notes, adding up cols. and multiplying sums by factors given. Take cuts to nearest tenth of a foot.

If cuts at 35' radius are not taken, formula becomes:

$$V, Cu.Yd = 25.25\,[6\,C_o + C_1+C_2+C_3+C_4+\cdots C_{12}]$$
$$+ .909\,[C_1s_1+C_2s_2+C_3s_3+\cdots C_{12}s_{12}]$$
$$+ .007272\,[C_1s_1^2+C_2s_2^2+C_3s_3^2+\cdots C_{12}s_{12}^2]$$

The above to be used only for sections 30° apart, slope $1\frac{1}{2}$:1, and radii as above.

TANK GRADE 105' DIAMETER FOR 37 500-BBL. TANK



Find in field:
Cut at center = C_o
Cuts at circumference, 30° apart, = C_1 · C_2 ··· C_{12} (ft.)
Cuts at 30 ft. radius, 30° apart, = h_1 · h_2 ··· h_{12} (ft.)
Elevations of slope stakes, s_1 · s_2 ··· s_{12} (ft.) above grade

Side slope $1\frac{1}{2}$:1

Volume, Cubic Yards:

$$V = 34.9\,C_o + 14.81\,[h_1+h_2+h_3+\cdots h_{12}] + 9\,[C_1+C_2+C_3+\cdots C_{12}]$$
$$+ 0.7636\,[C_1s_1+C_2s_2+C_3s_3+\cdots C_{12}s_{12}]$$
$$+ .007272\,[C_1s_1^2+C_2s_2^2+C_3s_3^2+\cdots C_{12}s_{12}^2]$$

GENERAL FORMULA, SMALL TANK-GRADES

Radius of Grade = R ft.
Cuts at circumference 30° apart = C_1 · C_2 ··· C_{12} ft.
Center cut = C_o ft.
Slope stake elevations = s_1, s_2, ··· s_{12} ft. above grade

Volume, Cubic Yards:

$$V = .006464\,R^2\,[6\,C_o + C_1+C_2+C_3+\cdots C_{12}]$$
$$+ .014544\,R\,[C_1s_1+C_2s_2+\cdots C_{12}s_{12}]$$
$$+ .007272\,[C_1s_1^2+C_2s_2^2+\cdots C_{12}s_{12}^2]$$

The above apply only for sections 30° apart and other conditions as stated.

TANK GRADE NO. 765

Diameter 125' – for 55 000-Barrel Tank.

Rod reading at "Grade" = 11.5

Azimuth	35' Rod	Radius Cut h	62.5' Rod	Radius Cut C			Slope Stakes Radius	Rod	Elev. s	Cs	Cs^2
0°	6.0	5.5	7.9	3.6			67.5	8.2	3.3	11.9	39.3
30°	5.7	5.8	7.9	3.6			67.3	8.3	3.2	11.5	36.8
60°	5.4	6.1	7.4	4.1			69.1	7.1	4.4	18.0	79.4
90°	4.6	6.9	6.2	5.3			70.0	6.5	5.0	26.5	132.5
120°	3.9	7.6	3.9	7.6			73.9	3.9	7.6	57.8	439.0
150°	3.5	8.0	2.0	9.5			77.1	1.7	9.8	93.1	912.4
180°	3.0	7.7	2.6	8.9			77.1	1.8	9.7	86.3	837.4
210°	4.9	6.6	5.1	6.4			72	5.2	6.3	40.3	253.9
240°	6.4	5.1	8.4	3.1			66.7	8.7	2.8	8.7	24.4
270°	7.2	4.3	10.2	1.3			62.5	—	—		
300°	6.9	4.6	9.3	2.2			62.5	—	—		
330°	6.3	5.2	8.1	3.4			65.6	9.4	2.1	7.1	14.9
Sums		73.4		59.0						361.2	2770.0
Factors		20.92		13.		Total Vol.:				.909	.007272
		1.5		177		47.4 C_o =	289.1			3.3	.01
		66.1		590		20.92 Σh =	1535.5			325.1	.19
		1468.		767.0		13 ΣC =	767.0			328.4	.55
		1535.5				.909 ΣCs =	328.4				19.39
Center	Cut =	6.1 = C_o				.007272 ΣCs^2 =	20.1				20.14
	47.4					Total Excavation	2940.+	Cu. Yds.			
	6.1										
	4.7										
	284.4										
	289.1										

ter of further interest is the use of flotation as a method for discrimination between chalcopyrite and scheelite in a concentrate derived from the treatment of ore from the Soctarie mine, which is one of the same group occurring along a lime-contact with intrusive rocks of granitic type. The Soctarie ore averages about 0.3% tungstic acid, 0.35% copper, and 0.02 oz. gold per ton. From this over 30% of the gold is recovered, 6% of the copper, and 51.86% of the tungsten. Scheelite elsewhere has been shown to be amenable to flotation with the common oils. It is interesting to note that it behaves differently with eucalyptus and camphor oil. Selective action is one of the most promising fields for the extension of flotation methods. Supplementary to cyanidation it is proposed to re-grind all oversize products in the mills of this company to minus 100-mesh in ball-mills, in order to render flotation more effective. By this means it is expected to improve the total extraction of valuable metals.

Report of the Canadian Nickel Commission

Nickel has often been referred to as a Canadian monopoly. While this is not strictly true, Canada does actually dominate the nickel market of the world. For many years the Dominion has sought to encourage the industry, and particularly to stimulate the refining of the metal at home. Recently a commission consisting of George T. Holloway, Willet G. Miller, and McGregor Young, with Thomas W. Gibson as secretary, was appointed to study the nickel problem. Their report has just been issued, making a volume of 600 pages, dealing with the nickel resources of the world, the mines, and the methods of reduction of the ores.

Two large plants for the refining of nickel are being erected in Canada. One is the property of the International Nickel Co. of Canada, Ltd., situated at Port Colborne. The company has obtained a site of 400 acres on which 2000 men are now at work. The initial output will be approximately 15,000,000 lb. of refined nickel per annum, provisions being made for doubling or quadrupling this capacity. The matte to be refined here will come from the smelters of the Canadian Copper Co. at Copper Cliff. For the treatment of this there will be required bituminous coal, coke, fuel-oil, nitre-cake, and other chemicals and materials, estimated at 100,000 tons annually. The plant is expected to be in operation by the autumn of the present year. The second refinery is that of the British America Nickel Corporation, Ltd., controlled and largely financed by the British Government, which has purchased the large Murray mine, the Whistle, and other deposits in the Sudbury region. This refinery will be erected at the Murray mine, about three miles from Sudbury. Electrolytic refining will be employed, using the Hybinette process. This is now in successful operation in Norway. The output of the Murray plant will be 10,000,000 lb. of nickel per annum. A custom smelter may also be erected as a stimulus to owners of nickel deposits of minor importance. The suggestion that the Government expropriate the deposits and plants of the Sudbury nickel area and operate them as a State monopoly has been discouraged. The commission points out that it would involve an outlay of more than $100,000,000, a sum equal to the total paid-up capitalization of the chartered banks in Canada, and that no certainty exists of being able to make adequate profits on so large an investment. In the past the output has had to be curtailed at times. If the price of nickel should fall, profits would naturally decrease. The nickel industry is to a considerable extent dependent for its success on the highly trained and specialized technical men who superintend it, and such men command salaries far beyond those paid in the government service to the most highly placed employees.

The ore-reserves of the Sudbury district are estimated at 70,000,000 tons of proved ore, and the total of proved, probable, and possible ore is put at 150,000,000 tons. The mines of New Caledonia are declared to be small compared with those of Canada. The largest yet worked has yielded 600,000 tons, and few of the New Caledonian deposits exceed 250,000 tons. The ores are richer than those of Sudbury, but are gradually showing a decrease in nickel-tenor. Neither do they contain copper and other valuable accessory metals. The cost of the refined nickel produced from the New Caledonian ores before the War was about 19c. per lb. At the present high prices for the metal it can be produced at a good profit, but below 25c. per lb. it might be difficult to keep these mines in operation. The deposits of Norway resemble those of Sudbury, but are leaner in both nickel and copper. They are also of smaller size, and are incapable of large expansion. Minor occurrences of nickel are known in Germany, Austria, France, China, Russia, Egypt, Italy, Tasmania, and the United States. Deposits similar to those of New Caledonia are found in Madagascar, but they have not been developed. Large bodies of nickeliferous iron-ore have been discovered on the island of Seboekoe near Borneo, and similar deposits have been worked for seven or eight years in Cuba.

The production of nickel as a by-product was investigated by the Commission. It is of considerable importance, and comes mainly from the electrolytic refining of blister copper, as copper ores almost invariably carry a small proportion of nickel. About 815 tons was obtained in 1915 through the refining of copper in the United States, and the tremendous increase in the production of copper will largely increase this quantity. In addition, scrap metal containing nickel is continually being retreated and the nickel recovered. The importance of the precious-metal contents of the Sudbury ores has not in the past been fully recognized. These consist of gold, silver, platinum, palladium, iridium, and other rare ele-

ments. The proportions of these metals in the ores are minute and appear to vary in the several deposits. Roasted matte from one of the companies showed 0.1235 oz. platinum, 0.197 oz. palladium, 0.027 oz. gold, and 1.84 oz. silver; in another case the matte showed platinum 0.988 oz., palladium 0.984 oz., gold 0.256 oz., and silver 6.155 oz. per ton. Platinum is scarce and the price unusually high. Palladium is being substituted for it wherever possible. Both of these metals are now worth at least five times as much per ounce as gold.

The great use of nickel is in the manufacture of nickel-steel, the ordinary form of which contains about 3½% of the metal. Compared with ordinary carbon-steel, nickel-steel has much greater strength and ductility, and is used in a wide range of industrial operations, in the manufacture of armor-plate, ordnance, projectiles, protective deck-plate, gun-shields, and other classes of naval and military equipment. Large bridges at New York, and over the Mississippi and Missouri rivers, dams, docks, the spillways on the Panama canal, and other large structures, illustrate the usefulness of nickel-steel. For locomotive forgings, marine engines and shaftings, wire cables, automobile parts, and the like there is a large and growing use. Many useful alloys of copper and nickel are produced, used for various purposes, such as bullet-casings, and plumbers' supplies. The use of nickel in the electro-plating of metallic objects is widely known. As finely divided metal, nickel is used as a carrier of hydrogen in the manufacture of fats from oils. This property of nickel causes it to be used by soap-makers. Pure nickel is used in coins, in the manufacture of watch and cigarette cases, and for cooking utensils. It is also drawn into wire for use in spark-plugs and electrical leading-in wires. Large buyers and consumers in Great Britain and the United States express the opinion that the uses of nickel will be extended, and that when normal peace conditions are restored, the demand will prove to be greater than before the War. A reduction of the price would undoubtedly increase the consumption and necessitate increased production.

The report also refers to a possible product from the Sudbury ores and slags, namely, nickel-copper-steel. A prejudice has existed against the presence of copper in steel, but recent tests have shown that the objections were not in all cases well-founded, if the copper percentage is not too high. The presence of a limited proportion of copper in steel is beneficial for some purposes, and it is also capable of advantageously replacing a proportion of the nickel in nickel-steel up to at least one-third of the combined quantity of nickel and copper. Experiments made for the Commission by Prof. George A. Guess, of Toronto University, fully confirmed these conclusions. Copper unquestionably gives steel greater resistance to corrosion, as demonstrated by elaborate tests conducted at the School of Mining of Queens University, Kingston, Ontario.

THE WOLFRAMITE OUTPUT of Siam increased from 602,267 lb. in 1915 to 950,400 lb. in 1916, the entire amount having been mined in the district of Nakawn Sritamarat, in the Siamese Malay States. The producing area has increased, and with the present high prices a still larger output may be anticipated. In the district of Trang, tungstate of calcium, scheelite, has been found, and is being worked on a small scale.

New Process for High-Grade Silver Ore and Concentrate

A plant has been erected recently by the Cobalt Reduction Co. for the treatment, by a new process, of high-grade ore and concentrate. The method was worked out by M. F. Fairlie, who demonstrated that after a preliminary treatment with bleaching powder ($Ca(ClO)_2 + CaCl_2$), this combination of minerals can be successfully cyanided. The low-grade ore is concentrated in the usual way on tables, the slime going direct to a cyanide annex. The table-concentrate is re-concentrated on tables and brought up to 2000 oz. silver, while the tailing is sent to the cyanide-plant with the slime. The rich concentrate, together with the high-grade ore, is then ground wet for 24 hours in a tube-mill equipped with iron linings and balls. Toward the end of the operation, 2% of bleaching powder is added. The bleaching powder oxidizes the refractory silver minerals making them amenable to cyanide treatment. The tube-mill charge goes to a Dorr classifier, where the metallics from the ore are removed together with the sand. The pulp is de-watered by an Oliver filter, and the treatment by strong cyanide-solution follows. The residue after filtration is sold on the basis of its cobalt and silver content. The silver-bearing solution is precipitated by sodium sulphide. The resulting precipitate is de-sulphurized in a small tube-mill by metallic aluminum and caustic soda. The silver is melted to fine bullion in a hearth-furnace. The oversize raked out by the classifier is given a low roast to eliminate part of the arsenic and is then melted to bullion. The small residue of speiss and slag is returned to the tube-mill with the next charge. By this simple process the corporation which was formerly one of the largest shippers of ore and concentrate in the district is enabled to market practically its entire output in the form of fine silver bar.—R. B. Watson in *Canadian Mining Journal.*

MAGNESITE is used largely as a refractory lining for the tilting furnaces in open-hearth steel manufacture; also for sorel cement in wall-panels and flooring, and as a filler in paper. The raw magnesite is calcined at a temperature between 400 and 650° C. For use as a refractory material the prevailing specifications of buyers call for a minimum of 85% MgO, less than 6% SiO_2, less than 4% CaO, and less than 5% loss on ignition. No limit is placed upon the Fe_2O_3 content, although actually the calcined magnesite sold for this use carries about 7%. For use in sorel cement and as a paper-filler the silica content may run as high as 12%, no limit is fixed for CaO, while Fe_2O_3 must fall below 1%.

Ventilation in the Rincon Mine

By BLAMEY STEVENS

Considering the extent to which the science of ventilation has been carried in coal mines, the lack of knowledge of most metal-mining engineers on the subject is notable.

Where natural ventilation is insufficient, we often see great sheet-iron pipes going down one or more of the several shafts of a mine or system of mines. This generally unnecessary, expensive, and cumbersome equipment is often fitted with a blower whose design is out of all proportion to the necessities of volume and pressure. In saying this, I do not forget that some of the better conducted metal mines have systems of ventilation rivaling that of any coal mine. The practice, as it applies to metal mines, has to be suited to the altered conditions, however, and the general principles should be better described in mining literature.

In metal mines, natural ventilation is for the most part relied upon, and in addition, air is carried to, or taken from the working-faces, where necessary, by means of pipes. In coal mines no pipes are used, but, as natural ventilation is entirely insufficient to keep dangerous gases from accumulating, a strong draught is forced through all the passageways of the mine. Development is carried forward by simultaneously driving parallel drifts in the vein or bed, and connecting them at intervals of a few feet. The current of air is trained by doors, etc., to pass up one of these drifts to the face and come back the other, thus scouring out all gas within a few feet of the working-faces.

This arrangement generally fails to interest the metal-mining engineer, for two reasons: he thinks the cost of a large ventilator and power to run it must be excessive, and he objects to the cost of running two drifts together.

In regard to his first reason: The average metal mine does not need a large draught; 20,000 cubic feet of air per minute is generally sufficient, and this can usually be got through the main drifts, with a loss of pressure equal to a half-inch of water-head. Work this out and it gives about 1½ horse-power, or, allowing for an efficiency of 50%, say 3 horse-power.

Such a ventilator would be about six feet in diameter, and its cost, in sheet-iron, a mere detail. It may be installed over a disused shaft or down the mine at the lowest level that has ceased to be much used. The latter position is generally preferable, as otherwise the old workings may short-circuit the current. All short-cuts that the air might take must be well boarded up and the cracks caulked. Men used to natural ventilation never give enough attention to the proper caulking. If doors have to be made, they should fit tight.

There are two or three forms of ventilator, but I think that known as the disc type is best suited to metal mines. The volume of air is calculated from its velocity in a drift, this velocity being measured with an anemometer, which can be bought from the instrument makers. The difference of pressure created by a fan is measured by a manometer, which can be made in the assay-office. It is simply a piece of glass tube bent into U form and charged with colored water. One end communicates with the higher and the other with the lower pressure. The difference in level is the pressure as water-head, and may be measured with any rule. The fan should be suitable to the pressure and volume conditions. All the makers supply tables of the performances of their several sizes and types of fans.

It must be remembered, however, that no fan can reduce the resistance of the air-passages. For good results these should be as open as possible. Points in the main circulation that one can just crawl through are ridiculous. If only the manways of raises are available, the air should pass through three or four raises in parallel, so as to make the equivalent area of a drift.

It is hard to estimate what the resistance of any particular circuit of a mine may be. It is immediately obvious, however, when any kind of mechanical ventilation is installed, because the pressure is proportional to the square of the cubic capacity of air delivered.

The square of this delivery, divided by the pressure, therefore becomes the frictional constant, depending only on the length and shape of the passages traversed. With this constant determined by any one ventilator, the proper pressure for any desired capacity may be immediately calculated, and thus the most suitable ventilator or speed be designated.

In choosing a ventilator, it is best to get one larger than necessary rather than the reverse, for speed can always be reduced below what the maker specifies, though it should not be increased.

In a metal mine where two levels are being used at the same time, the draught may follow the vein to the limit of the mine, on, say, the bottom level, and then return on the one next to the bottom. When it reaches the raise nearest the shaft it may ascend to the old workings and thence out of the mine.

Plenty of cool dry air prevents timber from rotting, cools hot stopes, sweeps out unhealthy, bad air, and increases general efficiency, to say nothing of 'welfare.'

The best way for the air to travel is down the main shaft, so that this, with its expensive timbering, pipes, electric lines, cages, skips, cables, and other equipment, may be kept as dry and cool as possible. The pump-stations get the next benefit of the air and then it goes to the development-faces.

If the draught refuses at first to be turned back down the shaft, water may be sprinkled down from a hose, but if the shaft is normally dry, one should look out for the loose stuff behind the lagging.

If necessary for the more efficient working of the fan, the resistance may be reduced by making two short circuits instead of a single long one. The violence of the draught is then decreased, but not the average freshness of the air. In order to split up air-currents properly, it may be necessary to insert an artificial resistance in one of the circuits.

The average shift-boss has a fixed idea that the velocity and the inertia of the current are what makes it travel. Disabuse his mind of this illusion. It is the fall of pressure that counts.

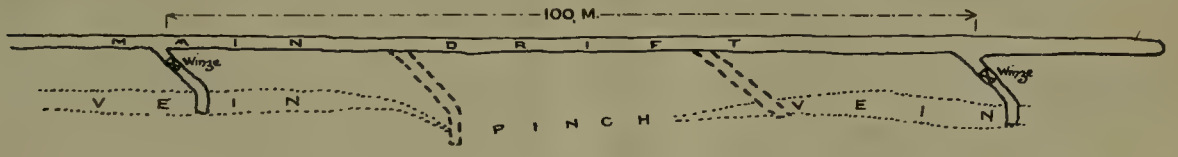
As for the double drift for the blind development, there are several ways of getting around it. If the drift is in ore, one can often break a heading for the stope a few feet behind the face of the drift and use this embryo stope for the return air-current. To ventilate a raise from this, connect the man-way to this stope and the ore-way to the main drift. If inconvenient to keep the ore drawn off, tap it a few feet higher, on the opposite side of the man-way. If progress must be forced, put down winzes from the level above, when there should be no trouble about ventilation. If nothing else can be done, one may string electric wire from the pump-station to run a small portable electric-driven fan at the end of a few feet of pipe running from the last raise. This is more efficient and economical than placing pipe the whole length of the drift.

For the last few years I have had to deal with what, as far as I can learn, is the most 'gassy' metal mine in the world, the Rincon in the State of Mexico, a mine of medium size, producing, under favorable political conditions, about 18,000 kilo. of silver per annum.

A large spring of tepid carbonated water has its source in the mine, and had retarded its development for twenty years. There were literally miles of pipe, but the air that they carried in or out was nothing compared with the carbonic acid gas that bubbled up everywhere on the lowest level. Because of the weight of this gas, natural draught would not raise it, except when the heat was excessive, and then but poorly. When conditions became unbearable to the men at the pump-station, which happened several times each day, they would turn live-steam up the shaft. From its mouth there generally issued a cloud of steam, which could be seen for miles. The timbers in the shaft were renewed yearly, and the rest of the mine-timber was changed almost as frequently.

Three large fans, placed advantageously, now ventilate this mine, with draughts fit to blow one's hat off, so that after four years timbers show little or no sign of rotting. Contract-prices were cut 30% on the average, and 50% in some places. Other improvements, however, also contributed to this effect.

The method of development now followed is to drive in the foot-wall country a straight drift of 0.5% gradient and having the mean course of the vein. Practically no timber is used. Winzes, also in the foot-wall, are sunk every hundred metres, this being found sufficient, seeing that the gaseous water is tapped only in the vein. When connection is made with a winze, and the draught established, the vein is tapped with a short cross-cut and allowed to drain, the main drift proceeding meanwhile. After the vein has drained itself down to a normal flow, it is found that from 25 to 30 metres can be driven on the vein without any difficulty in ventilation. This is somewhat remarkable; it is owing to the fact that the carbon di-oxide gas runs out along the bottom of the drift without seriously contaminating the air at the level of a man's head. This flow, however, will take place only for about the limited distance mentioned, after which, under normal working conditions, the level of contaminated air becomes sufficiently high to interfere with breathing.



LOWER LEVEL OF RINCON MINE.

Needless to say, when once diffused into the air, the carbon di-oxide never again separates and the whole volume must be swept from the mine as quickly as possible.

The vein is tapped, as often as necessary, from the main or working drift in the foot-wall. The subsidiary or vein-drifts are driven through and timbered on a more or less temporary basis, and only when ore is needed. These drifts are run only where there is workable ore. Enough of the air-current goes through the subsidiary drift without the use of doors. Raises are then put up in the workable ore without difficulty, and being connected above, and the resultant draught properly controlled, stoping operations can begin. After a part of the vein is worked out, the timbering is not renewed, but preparations are made for the protection of the stopes to be brought up from below.

While this method is primarily made necessary by the carbon di-oxide, it is probable that, even without the gas, it would not be more costly. No exact estimate of this comparison can be made from former figures of cost because of the difficult conditions then existing for driving on the vein. As an indication of these difficulties, the average gradient was 3%, owing to the fact that shift-bosses would not go to the faces to inspect the work. Only men bred in the district would work there. These

men worked after the manner of pearl-divers, laboring a few minutes and then going to put their faces in the mouth of the air-pipe for about an equal length of time. The crookedness of the vein on such a steep grade gave endless trouble in transportation and the steep gradient limited the water-storage capacity of the lowest level, so that, after three or four hours without pumping, the water would rise to the motors.

Although it has not been tried, we are satisfied that two 100-ft. levels might be taken together, the main foot-wall drift being driven only on the lower level, and the intermediate on the vein.

After the vein is drained and the auxiliary drifts put through, no carbon di-oxide appears above, because the ventilated drift keeps the gas from rising further in the vein. Nitrogen gas is found, however, in the raises and in blind drifts, this being due to the abstraction of the oxygen of the air by the decomposition of the sulphides. This well-known condition occurs in many localities and need not be dwelt upon here. As the gas is formed only above the bottom level, it presents no difficulty in a well-developed mine.

The difference of effect of the two gases is interesting. We find that a man easily lives in a nitrogen-charged atmosphere containing so little oxygen that a candle will not burn in it. Breathing is then only made more rapid as a result of physical exertion. The effect is apparently the same as that from a high altitude, the heart-action being rapid, so that probably the same amount of oxygen is distributed by the circulation through the body.

With carbon di-oxide, the reverse is the case. Quick deep breathing begins at once, and a candle will burn where a man falls unconscious. The greater relative effect on a man is probably due to the extreme solubility of carbon di-oxide. By solution it displaces oxygen in the blood. In the burning of a candle no solution takes place, so that the carbon di-oxide then acts only as an inert gas, much in the same way as nitrogen.

Carbide light is best for both gases, but the usual jet necessary for bright combustion, must be done away with as it blows itself out. A manner of temporarily remedying this is to make a little soft clay cap in front of the burner so as to direct a slow stream of the gas at a right angle to the usual direction of the jet.

THE USE OF the wet, sloppy mixture in making concrete, that has characterized recent American practice, is being changed in favor of the drier mix advocated by engineers 15 or 20 years ago. The dry mix is more homogeneous and durable. It is well-known that, with a moderate amount of water, the apparent moisture in the mix, and its consequent mobility, increase by somewhat prolonged mixing. Cement so prepared is superior to that poured very wet, and should be adopted always for the foundations of large engines and other machines. The use of the wet mix has been the out-growth of competition among contractors; shortening the time of mixing the concrete saves cost.

Laterite and Bauxite

Laterite is a term frequently mis-applied. Its technical use is to indicate a peculiar type of residual deposit resulting from the sub-aerial decay of igneous rocks under climatic conditions of high annual mean temperature and abundant moisture, involving areas that had been subjected to base-level erosion or at least to peneplanation, in districts favorable for the growth of excessive vegetation. The conditions favoring the accumulation of laterite, therefore, are those of the tropical jungle. The action of vegetable acids and abundant carbon di-oxide in the seepage-waters results in intensive kaolinization, with the removal of the excess of silica. In consequence a deposit of laterite is composed chiefly of clay and various hydrous aluminum silicates, together with large quantities of ferric oxide. The color is accordingly a deep iron-red. Laterite is essentially the home of bauxite, the hydrated oxide of aluminum, which is the necessary product of extreme de-silicidation, taking place in rocks subjected to the action described. The laterite deposits in the United States are remnants of those formed during the Mesozoic era, when tropical conditions prevailed over large parts of North America. The most extensive areas of these Mesozoic laterites are found in Arkansas, Alabama, and Georgia, and they are accompanied by valuable deposits of bauxite. Great lateritic zones are reported from the Guianas, from southern Venezuela, and from the interior basin of South America, said to hold important resources of this highly desired ore of aluminum.

MANGANESE ORE is at present sold in the Eastern markets in accordance with the following schedule: the long ton of 2240 lb. is the basis of calculation; in ores containing from 40 to 43% metallic manganese, payment is made at the rate of 71c. per unit of the metal; from 43 to 46%, 75c. per unit; from 46 to 49%, 78c. per unit; above 49%, 80c. per unit. The above prices are based on ores containing not to exceed 8% silica nor 0.2% phosphorus. Deductions from these prices are made as follows: for silica in excess of 8%, a deduction at the rate of 15c. per ton for each unit; for each 0.02% phosphorus in excess of 0.2% a deduction of 2c. per unit of manganese per ton, with fractions in the same proportion. Ore containing less than 40% manganese or more than 12% silica, or over 0.225% phosphorus are subject to refusal. Settlements are made on the basis of dry weight of ore determined on analyses of samples dried at 212°F. As all metal quotations are subject to change without notice confirmation of prices by wire should be obtained in advance of shipment. The figures given are f.o.b. Pittsburg, Chicago, and Atlantic terminals.

DE-VITRIFICATION of fused silica, known as 'quartz glass,' is due to a tendency to crystallize when the temperature is below that of the fusion point of cristobalite (1625° C.). When it passes the inversion-point at 200 to 275° it tends to break up as a chalky de-vitrified mass.

Aluminum-Dust Precipitation Tests

From Notes by P. H. CRAWFORD

The following article is from data obtained in tests made at the Divisadero mill in the Republic of Salvador.

In making the tests everything was done to imitate working practice as nearly as possible. Enough ore was ground in the assay-office for the entire series of tests, thus affording the same metal-content throughout, the pulp having been well sampled at the start. The ore was battery-feed saved from several days' samples and ground to pass 150-mesh, except for 2.57%. Two small pachuca vats were used. With a few inches to spare they held 44,000 cc. of solution and 11,000 gm. ore-feed. This gave a ratio of 4:1. Except for the third test, which had only 50 hours' treatment, they received 60 hours' air-agitation. Using the two tanks mentioned, we were able to treat 22 kgm. of ore per charge. For filtering the pulp a small Johnson press was secured. It held a little more than a single pachuca charge, but by pumping only one charge at a time, room was available between the cakes formed in each space to give a water-wash, that being necessary to compensate for the loss in moisture and solution used in making titrations and assays, and also to bring the filtering practice nearer to that on a working-scale. For the precipitation of gold and silver from the solution and for preventing the re-solution that takes place when filtered in contact with air, a small press was used, to which was connected a small pump, and, after the necessary time of contact, the solutions were passed through. These presses were attached to the pumps. The pump from the slime-press was connected by a small hose to the bottom of the pachuca vats, so that the pulp could be drawn direct, and, when the vat was empty, could be given a water-wash and that solution pumped through the cake and used in the next test for making up to the proper strength.

To precipitate the lime from the solution after treatment, and before precipitation of the precious metals, soda-ash was added to the pulp-charge about two hours before filter-pressing it, the solution coming out ready for precipitation, and the lime going with the tailing. Soda ash is added as a preparation for aluminum-dust precipitation in order to remove calcium from the solutions. In so doing it generates the caustic soda required for the purpose, according to the reaction: $Ca(OH)_2 + Na_2CO_3 = 2NaOH + CaCO_3$. If calcium is not removed it gives rise to a very troublesome precipitate of calcium aluminate, which lowers the grade of the silver precipitate and renders it difficult to melt. The solution from the press was so clear that it was not necessary to filter before titrating. This was true, even when testing for free KCN, where the end-point cannot be determined unless the solution is perfectly clear. The amount of soda-ash used is given, and also the results obtained on each test. It will be found that more sodium carbonate was used in the last test than in the others, due to the fact that more caustic soda was required for precipitation of the gold and silver. Therefore an excess of lime was added in starting the treatment, making it necessary to add more soda-ash to precipitate it. This gave the needed caustic. On a working-scale the solutions would have enough, and even less would be used. It is not necessary to have excess lime, unless required for settling pulp.

The solution coming from the pulp-press was run direct to an iron drum used for mixing the aluminum-dust. In practice it would be the contact-tank, but in that case it would be necessary to have two of them. Indeed, we should have used two, but this would have made more work for the shop, as the necessary connections would have taken time. The reason for using two tanks is that no air should come in contact with the precipitate after being formed. Having two tanks, the solution entering the top of the first, with the necessary aluminum-dust, is at once given violent agitation; the solution passes downward on its way to the outlet placed near the bottom, from which point it rises through a pipe to the level of the solution in the first tank, which it had just entered, and then passes downward to the next, where it enters the side near the bottom and is retained as long as necessary for precipitation, meanwhile being violently agitated to keep the precipitate well divided and to expose fresh aluminum-surface as the precipitate is washed from the metal-particles by the agitation. In using one tank it proved necessary to keep the solution agitated as much as possible by stirring with a wooden paddle. The amount of air taken into solution in this way and passed, after precipitation has taken place, to the vital part of the process, namely, the pressing, is open to question, but for small test-work the results as a whole are not bad. It must be stated, however, that an excess of precipitant was found necessary to bring the solution-tailing as low as we did. The clear solution from the presses would point to an exceptionally rich precipitate in practice. The ratio of solution to ore was 4:1, in order to be able to use a sufficient quantity for check titrations, assays, etc., in case of necessity, and also for the reason that, though in practice the ratio of pulp to solution in agitation is 2:1, in the mill the ore comes in contact with 7 to 10 times that amount of solution. In this test the amount of soda-ash used was twice what it would be in actual practice. In making small tests it seems impossible to secure total precipitation with the amount of aluminum-dust sufficient in large-scale operations. The proper amount must be ascertained in the works.

A lower strength of solution was used than is at pres-

ent employed in the mill while precipitating with zinc. If this should be found strong enough in actual practice with aluminum there is a further saving to be made in cyanide, and from the results on the four tests I see no reason why the lower strength could not be used. If a stronger one be employed the extraction should be even better. It must also be borne in mind that the ore used in these tests was finer than that treated in the large pachucas in the mill, that is, there was less plus 150-mesh material, though perhaps the quantity of minus 150-mesh was on the whole not so finely comminuted. The extraction in actual practice should, if anything, be a little better than that shown by the small tests, due to the fact that an excess of aluminum-dust is used for precipitation, and if there were a tendency for aluminum solutions to become foul it should show up here. As a matter of fact almost the same extraction was obtained in the last test as that in the first when the solution was new. I doubt that this could be done with zinc-dust, even using the exact amount necessary for precipitation, or using the same ratio as maintained in the mill, in spite of it being extremely low. The average extraction in the four tests, including the 50-hour agitation, was as follows: silver 92.59%, gold 98.48%, total 94.14%. This is the percentage dissolved up to the time the solutions are treated with soda-ash. If there is any great loss in the filters, or if no further extraction takes place there to overcome the loss, the foregoing figures would not hold on a working-scale, although that would not be due to any fault of the solutions.

The details for successful precipitation are hard to settle in these small tests. There are many things to be overcome on a laboratory test that are taken care of in practice by arrangement of the proper tanks, whereby no air may enter the solutions after precipitation begins. The rate of flow, length of contact, and amount of aluminum-dust fed are mechanical details that have been overcome and are now doing good work in several plants. To make a test that would overcome all these difficulties, it would be necessary to have miniature tanks, pumps, presses, dust-feeder, etc., with the necessary pipe-connections and valves, so that every stage of the process could be regulated as in large-scale work. If the least air is allowed to enter the press, or reaches the precipitate, there will be some precious metal re-dissolved and the tailing will run high. In making the small tests, everything possible was done to overcome this, the resultant tailing-solutions being generally low. Two of them were exceptionally low for this kind of work, but for some reason the gold would not come down like the silver. I am told that this is also true with the zinc-precipitate in present practice.

To arrive at the necessary amount of aluminum-dust that would be required to precipitate the gold and silver per ton of ore, a series of precipitation tests were run. On using up all the solution from the last test, that being the fourth time it was used, the residues were sent to the assay office. When the returns came it was seen that something had gone wrong with all but the first three. On looking over the pump and press used for that test, a small hole was found in the rubber tubing employed as pump-suction. Beyond doubt that was the reason for the high tailing in all but the first three tests, though the amount of aluminum-dust used in most of them is lower than the previously estimated 0.43 lb. per ton.

The details of the tests are shown in the accompanying table:

Test No. 1. In starting the tests a new solution was made up, taking 88,000 cc. water, to which was added 172.48 grammes NaCN and 242 gm. lime. The solution was then mixed with 22,000 gm. battery-feed ground in the assay office, so that all of it passed 150-mesh except 2.67%. In this test, as well as in the other three, the ratio of solution to ore was 4:1. The soda-ash necessary in practice would have been 2 lb. per ton of ore treated. Agitation was accomplished in two small pachuca vats, using air, the time of contact being 60 hours. To test No. 1 was added aluminum-dust at the rate of 0.70 lb. per ton of ore. This was added little by little to the bottle in which the contact was being made, so that perhaps the third part was added during the last 5 minutes, the total contact-time being 15 minutes. The bottle was agitated by hand to wet the dust and then placed on the rolls.

Test No. 2. In this test the solution from No. 1, after precipitation, including the water-wash, was used. To bring this up to the necessary strength 58.64 gm. NaCN and 156 gm. lime were added. The water-wash was used to make up for that lost in moisture, in titrations, and for assay. The same amounts of ore and solution were employed. The treatment was also identical. The soda-ash in practice would have been equivalent to 1.5 lb. per ton of ore. Test No. 2 had the same amount of aluminum-dust added, but was violently agitated by shaking the bottle, this being kept up during the whole time, the dust having been introduced as a whole at the start, and the cork not being removed until it was time to pump through the press.

Test No. 3. For this test the precipitated solution from the previous test, with the wash-water, was taken. To bring this solution up to the necessary strength 45.74 gm. NaCN and 187 gm. lime were added. Just enough wash-water was forced through the pulp to make up for that lost in moisture, titration, and assays. The same ratio of solution to ore was used as in previous tests.

The soda-ash necessary to precipitate the lime after treatment, which is before aluminum precipitation, was at the rate of 0.9 lb. per ton of solution, and in practice would have been 1.8 lb. per ton of ore. The extra lime was added to bring up the strength in caustic. Test No. 3 was made in a smaller bottle and 0.35 lb. of aluminum-dust added. It was corked and placed on the rolls for one hour; then pumped through the press.

Test No. 4. The precipitated solution from the previous test was used, plus the wash-water that was passed through the cake in the presses to make up for the amount lost in moisture, titration, and assaying. To bring the solution up to strength 48.62 gm. NaCN and

242 gm. lime were added. The extra lime was used for the purpose of bringing the solutions at the end of the treatment nearer to the strength that would be used in actual practice. This necessarily demanded more soda-ash on this test, but in actual practice it would not, as the caustic that it is endeavored to get in this way would be in the working solutions. The soda-ash would be equivalent in practice to 2.50 lb. per ton of ore, but this would be less, as the necessary caustic would be present. In addition to the above, other tests were made which were faulty. The higher results were probably due to accidental admission of air. A résumé of results from the additional tests is given in the table below:

Number of test	Aluminum-dust used, lb.	Time of contact	Method of agitation	Tailing assay silver oz.	Tailing assay gold, oz.	NaOH
4	0.30	20 min.	Shake-rolls	0.53	0.021	0.0897
5	0.55	20 "	" "	1.66	0.011	0.0487
6	0.30	X 20 "	" "	0.49	0.020	0.0487
7	0.35	X 30 "	Shaking	1.05	0.032	0.0487
8	0.35	X 15 "	"	0.72	0.030	0.0487
9	0.65	X 60 "	Rolls	0.475	0.018	0.0487
10	0.35	X 30 "	Shaking	0.64	0.021	0.1300
11	0.35	X 15 "	"	0.45	0.019	0.1300
12 (lead acetate, 0.1 lb.)	0.35	? 15 "	"	1.84	0.030	0.0487

Those having X before the time-item had the cork in place during agitation, in order to keep the air out as much as possible. The only air admitted was that in the bottle, in the space allowed for agitation. In the last test 0.10 lb. lead acetate was added. It is suspected that the cork in this case may have been removed by an assistant. These tailing-assays are high, including those with an excess of aluminum-dust. Some precipitation-tests were made in pails, in which the aluminum-dust was added and stirred with a wooden stick for 35 minutes, but the resulting tailing was so high that they were valueless.

The conclusion to which the tests lead is that an important saving in cyanide is effected by using aluminum-dust for precipitation instead of zinc-dust. In summary, the advantage gained is approximately 1.6 lb. cyanide saved by regeneration in precipitation; 0.35 lb. saved in the washing in the presses; and an economy of 0.15 lb. by reason of the lower permissible strength of solution for equivalent results. The total saving effected is, therefore, about 2.1 lb. in the case of the ore on which the experiment was made.

EXTRACTION OF PRECIOUS METALS BY ALUMINUM-DUST PRECIPITATION

Free KCN in terms of 100%:	Test No. 1	Test No. 2	Test No. 3	Test No. 4
Before agitation, per cent	0.2436	0.2525	0.2525	0.2562
After agitation, per cent	0.1862	0.1975	0.2012	0.1950
Consumed during treatment, per cent	0.0574	0.0553	0.0513	0.0612
Solution titrated before precipitation, per cent	0.1862	0.1972	0.2012	0.1950
Solution titrated after precipitation, per cent	0.2037	0.2150	0.2212	0.2150
Regenerated by aluminum precipitation, per cent	0.0175	0.0178	0.0200	0.0200
Free KCN regenerated by aluminum precipitation, lb	1.40	1.424	1.60	1.60
Lime added per ton of ore, lb	22.00	15.00	17.00	22.00
Soda ash needed at end of treatment per ton solution, lb	1.00	0.75	0.90	1.25
Gold, original ore, ounces per ton	0.1300	0.1300	0.1300	0.1300
Gold tailing, ounces per ton	0.0017	0.0017	0.0025	0.0020
Gold extracted, ounces per ton	0.1283	0.1283	0.1275	0.1280
Gold extraction, per cent	98.69	98.69	98.08	98.46
Silver, original ore, ounces per ton	14.63	14.63	14.63	14.63
Silver tailing, ounces per ton	0.99	0.99	1.295	1.06
Silver extracted, ounces per ton	13.64	13.64	13.335	13.57
Silver extraction, per cent	93.23	93.23	91.14	92.75
Total value, original ore	$9.915	$9.915	$9.915	$9.915
Total tailing	$0.529	$0.529	$0.6975	$0.57
Total extracted	$9.386	$9.386	$9.2175	$9.345
Total extraction, per cent	94.66	94.66	92.97	94.25
Head solution, gold ounces per ton	0.0320	0.0340	0.037	0.0400
Tailing solution after precipitation, gold ounces per ton	0.0025	0.0060	0.012	0.0055
Precipitated, gold ounces per ton (solution)	0.0295	0.0280	0.025	0.0345
Extraction by precipitation, gold, per cent	92.25	82.35	67.57	86.25
Head solution, silver ounces per ton	3.410	3.600	3.800	4.00
Tailing solution after precipitation, silver ounces per ton	0.035	0.021	0.106	0.07
Precipitated, silver ounces per ton (solution)	3.375	3.579	3.694	3.93
Extraction by precipitation, silver, per cent	98.97	99.42	97.21	98.25
Head solution, value	$2.3460	$2.480	$2.640	$2.800
Tailing solution, value	$0.0675	$0.130	$0.293	$0.145
Precipitated, value	$2.2775	$2.350	$2.347	$2.655
Total extraction from solution, value, per cent	97.12	94.76	88.90	94.82

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

CRITICAL TEMPERATURE is the point above which any substance will remain in a gaseous state without reference to pressure.

LITHARGE used by assayers always contains a small amount of silver and sometimes a little gold. The presence of these metals can be determined and proper allowance made by the assayer therefor.

MICA employed as an insulator in electrical work must be free from iron minerals and other foreign substances, or its value for this purpose will be impaired in proportion to the amount of foreign mineral present.

EXPANSION of alloys on cooling is sometimes important. A mixture of one part bismuth, two parts antimony, and nine parts lead will expand upon cooling, which makes it useful for certain purposes. Most metals and alloys shrink upon cooling.

THE PROPERTIES of ferrous oxide, FeO, according to Robert B. Sosman, are still practically unknown. Most of the methods by which it is prepared yield only a mixture of metallic iron, or of an iron carbide, with an oxide having a composition falling between FeO and Fe_2O_3.

INSTEAD of inquartation a Central City, Colorado, assayer introduces into the assay-charge, after it has been put into the crucible, a measured quantity of standard silver-nitrate solution, then adding the salt-cover. The silver-nitrate solution is drawn into the charges from a burette.

HYDRAULIC-JACKS are among the handiest tools to have about a mine. Their usefulness cannot be overestimated. No mine should be without one or more of them. They are useful on the surface, but more so under ground. The common track-jack, though less powerful, is a most useful device, and there should be one of every level of a well appointed mine.

A BLAST-FURNACE was built several years ago at Butte, Montana, which was 72 inches wide at the tuyeres. It is said to have worked well with coarse ore, but was unsatisfactory with the usual run-of-mine ore, which contains a great deal of fine material. This renders successful smelting in so wide a furnace impracticable. The usual working height of the ore column in a blast-furnace over 36 in. wide at the tuyeres is about 14 feet.

RADIUM-BARIUM SULPHATES carrying considerable silica may be readily converted into carbonates by fusing with a mixture of sodium carbonate and hydrate, as determined by recent experiments in the laboratory of the Bureau of Mines at Golden, Colorado. The amount of sodium carbonate required ranges from 10 to 15%. The reaction occurs at a low temperature. The product is easily washed free from sodium silicate.

CONCRETE in contact with sea-water undergoes serious changes in chemical composition. Concrete piers of a bridge across the Shrewsbury river, New Jersey, recently failed, and inspection showed stratification into alternate layers of a putty-like substance, sand, and gravel. Samples from the altered cement showed nearly equal parts of magnesium, calcium, and the oxides of iron and aluminum. The magnesium of the sea-water replaces the calcium in the cement.

PLACER MINERS give sluice-boxes a grade which in their judgment will accomplish satisfactory results, varying from 8 to 14 in. to the 12-ft. box. In some instances the grade is set lower than is deemed advisable owing to the low fall of the gulch or valley where mining is in progress. The boxes may be given a grade greater than the creek, in fact, this is generally necessary to keep the drainage clear. From 30 to 40 cu. ft. of water per minute is considered a 'sluice-head' for a 12-in. box.

DISCHARGE of water that will issue from the bottom of a tank or reservoir through a pipe of given dimensions depends upon the vertical length of the pipe, and the friction. A reservoir would be more quickly emptied if discharging through a 10-in. pipe, the lower end of which was 200 ft. below the bottom of the reservoir, than it would if the same pipe ended but 100 ft. lower than the bottom of the reservoir. Friction is a factor to be considered, particularly in long pipes.

OZOKERITE combines the chemical inactivity of paraffine with the physical properties of beeswax, that is, it possesses a peculiar plasticity that admits of its being kneaded. Its value is enhanced by the fact that its melting-point is higher than either paraffine or beeswax. Ozokerite, and its waxy derivative ceresin, are used in the manufacture of candles, as insulation for cables, and in shoe, stove, and floor-polishes. It is a hydro-carbon found in veins, and apparently formed as a result of distillation from highly altered carbonaceous shales and lignitic rocks.

PROSPECTORS who agree to go prospecting on a grub-stake cannot quit their backers at will. It is better to have a date distinctively stated limiting the term of partnership. Necessarily it involves honesty and fair dealing on the part of the prospector, who is supposed to search vigorously, using all the knowledge that his experience has brought him, for the common good. The prospector may find a rich deposit, and cover it up or fail to make the fact known until the term of his grub-stake agreement shall have expired, but an honest man will not attempt such meanness. In grub-staking the essential matter is a 'square deal' all around.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

LEADVILLE, COLORADO

IMPORTANT DISCOVERIES IN UNDEVELOPED TERRITORY.—PROPOSED TUNNEL PROJECT FOR PROSPECT MOUNTAIN.

What appears to be the making of one of the largest and richest mines in the Leadville district has recently been discovered near the Lackawanna, a territory that is rapidly coming to the front as an important gold producer. A large fissure-vein on the Ozark property adjoining the Mt. Champion has been opened within the last two months and an ore-shoot over 200 ft. long, 100 ft. high, and 2½ ft. wide has been encountered. The ore assays from 5 to 7 oz. gold per ton. The vein traverses the entire property of 98 acres and it is believed that the ore-shoot also will persist with the vein.

Shipping from the Ozark was started February 1, the first carload bringing a net return from the smelter of over $3000. Since then, six other cars have been shipped, one of which, containing 35 tons, netted $4100.

The Ozark is owned by John W. McMahon, B. H. Martin, John Cortellini, and Dorsey Almond. The property is under a five-year lease to the Mt. Champion Mining Co. and is being developed through advanced laterals from the workings on the third level of the Champion mine.

Other big veins are known to traverse the Ozark, and it is planned to undertake the development of a number of them during the coming summer. It is believed that this work will uncover several new ore-shoots of high value and place the property in the front ranks of the rich producers of the district.

The ore is white quartz containing free gold and occurs in big fissure veins in the granite.

For several years the Mt. Champion property has been producing a steady output of high-grade gold-bearing ore, some of which ran as high as $1000 per ton. The veins from which this ore was extracted are the same as those that extend into the Ozark, indicating that continued development in the new ore-shoot will discover ore as rich as that found in the Champion.

The strike at the Ozark is undoubtedly one of the most important discoveries that have been made in the Leadville district during the last six months; a period during which some of the biggest and richest strikes in its history have been made. Interest and activity will surely turn to the Lackawanna territory early in the summer, as soon as surface work becomes practicable; and beyond doubt, the development then undertaken will uncover other rich shoots in the area surrounding the Mt. Champion and Ozark. The Lackawanna section offers numerous attractive mining opportunities, and the recent discovery will have a great bearing on their future development.

To keep pace with the rapidly increasing ore production from the district, the smelting and milling-plants are making the necessary extensions required for handling the tonnage. During the past year several important additions and improvements have been made at the Arkansas Valley plant of the American Smelting & Refining Co., and it is officially stated that others will be completed as soon as the equipment can be secured.

Simon Guggenheim, president of the A. S. & R. Co., accompanied by Edgar L. Newhouse, Carl Eilers, Henderson Green, and F. H. Brownell, president of the Federal Smelting & Mining Co., of Idaho, visited Leadville recently on a tour of inspection and stated that extensive plans for increasing the capacity of the Leadville plant and carrying on the welfare work for the employees are now being perfected by the company.

"I am especially pleased to be able to announce that a fund of $500,000 has been set aside for the welfare work in all of our plants, and while much has been done in the Leadville plant, we expect to add to this materially," Mr. Guggenheim said. "There will be shower-baths, club-rooms with pool and billiard-tables, and other accessories for improving the condition of the men. When necessary we will not only look after the welfare of our employees while they are at the plant, but will take an interest in those vital questions of home life and living conditions. Trained nurses will be provided when necessary, and other steps taken in looking after the families of our employees. We believe in dividing our profits with our men. Irrespective of this, wages have been increased in all our plants and every effort has been made to look after the best interests of our employees. It is the purpose of the company to increase the facilities for taking care of the increased production of ore which is being stimulated by the growing demand for metals. It is our aim to co-operate with the miners whenever additional extensions to our plants are required, for we fully recognize that their interests and our interests are identical. Of course, in times like the present, it is difficult to procure the necessary equipment for immediate delivery, but we are making special efforts in that direction. I find that the mines here are showing increased activity and that the town is more than holding its own. Leadville may well pride itself on being one of the premier metal-producers of the West, and our faith in its future is indicated by the fact that we are actively engaged in making whatever additions and improvements the conditions at our plant call for."

George Cramer & Co., leasing the Star No. 5, Ladder, Catalpa, Waterloo No. 1 and 2, and the Yankee Doodle, on Carbonate hill, are erecting a new jig-mill near their properties for the purpose of concentrating low-grade lead-iron ores, immense bodies of which have been found in those mines. The plant will be the first of its kind in the district, and has been demonstrated to be successful in handling this particular kind of ore. It is stated that the mill will begin with a 50-ton capacity but will be so built that new units can be added without difficulty. The plant will probably be ready for operation within two months.

The Western Zinc Oxide Co. has been considering a plan for increasing the capacity of their plant, and it is now reported that the work of enlarging will be undertaken this summer. As the plant now stands, it is capable of treating 60 tons of zinc carbonate daily. When the work of extension is taken up it is planned to install a roasting-plant so that sulphide ores also may be treated.

A large company, strongly financed, is being organized by A. A. Garrett, of Leadville, for the purpose of driving an adit into Prospect mountain from the Arkansas Valley side. The enterprise is regarded as one of the most promising in the district. The proposed adit will be several hundred feet below the workings in the Anderson tunnel, at Birdseye, or the Silver Spoon tunnel in the Big Evans gulch.

Ore has been encountered in the Silver Spoon, and during the past year a large tonnage was shipped from the property. At the present time, it is closed down, but it has been stated that operations will be resumed during the summer on a

larger scale than before. This indicates that the discovery in the tunnel was an important one, and adds materially to the possibilities of the deeper project from the Arkansas valley.

The strike at the Silver King property on Yankee hill is gradually growing in importance, and indications are that a strong ore-shoot will be discovered with continued development. The first shipment from the property will be made during the coming week.

UTAH

NEW MINE-TAX LAWS.—MINE LICENSES.—TAX ON NET PROCEEDS.—WORKMEN'S COMPENSATION ACT.—NET PROCEEDS OF MINES.—ELECTROLYTIC ZINC.—RADIUM MINING.

The legislature has finished its session and the mining industry now knows what it must face in the next two years. The income-tax bill was killed in the Senate after passing the House unanimously. Compensation and special-tax measures were passed. Prior to 1916 all property other than mines was taxed at 30 to 40% of its value, whereas mines paid taxes on their net proceeds, in addition to a valuation on the land and improvements. When in 1916 other property was assessed at full value, an attempt was made to assess mines at three times their net proceeds in addition to the other taxes, by means of an amendment to the constitution. That was overwhelmingly defeated at the polls. As a result the proportion of the total taxes derived from the mines was smaller than in preceding years. This, coupled with the war-time prosperity of the mines, engendered a feeling among representatives that some means should be found to make the mines bear as large a share of the burden of taxation as could be forced upon them, regardless of the lean years of the past. The failure of the constitutional amendment, and the fear that an attempt to apply the same method by statute would be declared unconstitutional, led to the enactment of another bill that seems no less discriminative and unconstitutional. It is called "An Act Providing for an Occupation and Privilege Tax on the Business and Occupation of Mining"; in other words, a license-tax aimed solely at the mining business, partaking of the form of an income tax. All persons, associations, and corporations engaged in the business of mining, as owners, operators, lessees, or lessors (employees and laborers alone excepted), unless location work or assessment work amounting to less than $500 is being done, must pay a tax of $1 each, plus 2% of the net proceeds of the mine. To make up for last year's deficiency the rate is to be 3% for this year. The mining companies are required to prepare complete statements of income and expense, in which all direct operating expense may be included except salaries of officials not on the mine. The usual penalty and forfeiture clauses are provided.

A constitutional amendment also is to be submitted to the voters providing that metal mines shall be assessed at $5 per acre plus "some multiple or sub-multiple of the net annual proceeds thereof." All machinery and surface improvements would be assessed at full value. The State Board of Equalization is to be the assessing authority. All other mines, especially mines containing coal or hydro-carbons, are to be assessed at "full value." A compromise measure was passed at the end of the session providing workmen's compensation. State, mutual, and casualty insurance is provided, and financially responsible employers may carry their own insurance after satisfying the authorities as to their ability to meet the claims. Among the features of the new law are the following: "Employees may not pay dues into any company organized to provide compensation for injury or death; non-resident alien dependents are allowed but one-half the regular rate, with a maximum of $1000; if the employer is not insured in the State fund, he must, in case there are no dependents, pay funeral expenses and $750 into the State fund in cases of injury resulting in death; if death results within three years of the date of injury, the wholly dependent persons are to receive compensation at the rate of 55% of the average weekly wage, not exceeding $15 per week, for a period of six years from the date of injury, but not less than $2000 nor more than $4500; benefits cover periods from 6 to 200 months; 10 days is the waiting period; medical aid not to exceed $200 must be provided in cases of injury; a State Industrial Commission of three members, one of them the State Insurance Commissioner, is provided to administer the act; the offices of State Coal Mine Inspector and Commissioner of Immigration, Labor, and Statistics are under the jurisdiction of the Commission. In order to discourage litigation that might otherwise occur through a provision of the constitution that no statutes shall be passed depriving dependents of the right to sue an employer for injuries to a provider resulting in death, the Commission is given as full powers as possible to decide compensation-cases. Its denial of the right of the claimant to compensation on the ground that the injury was self-inflicted or that the accident happened out of and not in due course of employment, may be reviewed by the district court, and, on further appeal, by the Supreme Court of the State. Employers complying with the provisions of the act are not liable in damages for injuries not resulting in death. In case of death the dependents have the option of accepting the authorized compensation or suing in the courts, in which event all the common law defenses of the employer are made available. If dependents accept the provisions of the act, they are barred from any action at law, and, if they elect to try the case in the courts they cannot claim compensation under the act in the event of an unfavorable verdict. This law is regarded as one that fully protects the employee, without working hardship upon the employer, as would have been the case had the more radical proposals been incorporated.

The Ontario mine has won its taxation-suit. The county treasurer of Summit county had sued to collect taxes on an assessment of the Ontario drain-tunnel at full value, under the provision of the constitution that makes other property than the mine taxable at full value. The Supreme Court held that the tunnel was a necessary part of the mine and of no value except in connection therewith. Net proceeds of 54 mines, as reported to the State Board of Equalization, amount to $38,299,516 in 1916. In this preliminary list are included 12 coal mines with total net proceeds of $1,343,618; 15 Tintic mines, $1,639,892; 8 Bingham mines, $33,809,914; 2 Park City mines, $257,183; 4 Stockton-Ophir mines, $529,464; 3 Beaver county mines, $87,194; 2 Cottonwood mines, $402,161; and 4 mines producing asphaltum, gilsonite, and elaterite, $116,565. The Park City sampling plant of the Utah Ore Sampling Co. has been dismantled and the business transferred to the enlarged plant at Murray. The Judge Smelting & Mining Co. has started the production of electrolytic zinc, but the exact production or the purity of the output has not been made public. The California-Comstock mines, connecting Park City with the Big Cottonwood districts, have been re-opened and development is proceeding on a large scale under new management. The property is well equipped with buildings and machinery. It was the scene of extensive development in earlier days, and several interesting geological problems now await solution. The Boston Development Co. has cut another large dike of granodiorite porphyry in the north-western part of the Maxfield mine in Big Cottonwood, and is driving both north-east and south-west seeking a favorable limestone bed in which to look for ore. The other large shoots of ore have been found near the porphyries that were cut in the eastern portion of the property. These pitched to the north-west. The company has expectations of finding another orebody in this part of the property where work is carried on 2200 ft. below the surface. Some good ore was found here in the early days. Fire in the stopes of the Utah-Apex at Bingham compelled withdrawal of the pumps so as to flood the mine. Over 400 men will be laid off for at least ninety days. The revival of the radium-mining industry that had been prophesied seems

to be near. The Consolidated Ores Co. has announced that work is to be resumed on its deposits near Moab, and other operators are expected shortly to resume.

JOHANNESBURG, TRANSVAAL

Sudden Flood of Water in East Rand Proprietary.—Mineral Output of South Africa in 1916.—State Mining.

In a previous letter mention was made of a novel prospecting scheme at the East Rand Proprietary mines for proving the reef at a depth of 6000 ft. from the surface, at a point 2000 ft. south of the present workings, where development had given unsatisfactory results. The proposal was to drive a cross-cut from No. 27 level at a depth of 4000 ft. from the surface, for a distance of 2000 ft. and then sink 2000 ft. to the reef.

This cross-cut, however, had only just started when it tapped a body of water described as an underground river, the inrush of water being nearly 5,000,000 gal. in 24 hours. This is a great flow of water to be dealt with at a depth of 4000 ft., but with the concentration of the pumping-facilities, and by bailing in addition 1,000,000 gal. per day, the water was kept sufficiently under control to allow a bulkhead to be built at the entrance of the cross-cut. Even with a by-pass allowing a flow of 600,000 gal. of water per day, the pressure on the dam was 850 lb. per sq. in. Some of the water found its way into the incline shafts of the Angelo Deep, but the pumps responded well to the demand made upon them, otherwise the adjoining Hercules mine must have been flooded also. It was to obviate the water difficulty that the cross-cutting scheme was adopted, but this heavy in-flow of water came as a surprise, and it has become necessary to add to the pumping-facilities, which had been considered as adequate.

The total mineral production of South Africa reached last year a total value of £49,645,555, to which the Witwatersrand contributed in gold alone £38,094,786. The production of diamonds last year was 2,346,330 carats, valued at £5,582,976, being about the normal output, but at the present time all the diamond mines have resumed production, and this output is expected to reach a value of at least ten millions sterling. The coal output was 10,007,473 tons valued at £2,715,313, a record output, of which over 6,000,000 tons was produced in the Transvaal, and 3,000,000 tons in Natal. The total output of base minerals and metals other than coal, was valued at £1,751,184; copper, £1,132,140; and tin, £355,487, being the two largest items.

The tonnage milled by the Witwatersrand mines last year was 28,525,252 tons, as compared with 28,314,579 in the year 1915, and, considering the increased gold production, was more satisfactory than usual. The recovery per ton milled increased from 26s.3d. to 26s.8d., due probably to the increased tonnage from the Far East Rand mines that was milled during the year, where the value of the ore proved to be better than had been anticipated. Working costs increased from 17s.5d. to 18s.1d. per ton, due principally to increased cost of stores and allowances as a result of the War. Working-profits fell from £11,931,062 in 1915 to £11,630,001 in 1916, or from 8s.5d. to 8s.2d. per ton. These figures are exclusively those of the Rand and do not include the gold mines producing outside the Rand area, which during the year have fared badly.

The Far East Rand goldfield continues to attract attention, and now, that the Commission appointed to enquire into the Government working some of the areas has concluded the taking of evidence, its report is anticipated with interest. Since the Commission commenced its investigations, the controling houses have shown a more ready disposition to tender for some of the Far East areas, probably because the conditions governing the tenders were made more elastic by the Government. Previously the conditions attached to the tenders were considered too rigid, and the minimum too high, with the result that no tenders were submitted. It was this difficulty of obtaining tenders that led to the demand for a Government Commission to enquire into the advisability of the Government working the areas itself. However, as the recommendation of the Mines Department to ameliorate the conditions of tendering was adopted on the last occasion, the tenders handed in were more numerous, and the terms obtained by the Government as lessors were satisfactory. Providing similar terms can always be obtained by the Government the need for 'State mines' will not appear so pressing.

A variety of opinions has been expressed in the evidence submitted to the Commission as to the advisability of the Government adopting the principle of State mining. Some of the witnesses have expressed the opinion that the State ought to work the areas so as to receive the whole of the profits, no matter what tenders were submitted. Others recommended that only in the event of the Government failing to

A YOUNG MINE IN THE NORTHERN TRANSVAAL

obtain suitable tenders should the question of State mining be considered. Other witnesses urged that it is the duty of the Government to do all it possibly could to induce the public to tender for the leases, even if it involved the prospecting of the areas and sinking shafts, before calling for tenders.

There is little doubt about the Far East Rand goldfield being of uncertain value. Dr. Mellor, as assistant director of the Geological Survey, put forward the view that the reef had been deposited in elongated patches with a south-east axis, and that where the reef is well developed and of fair thickness, it is generally profitable. Extensive areas occur where the reef is practically absent, the foot and hanging walls coming into contact in places. In his evidence before the State Mining Commission, Dr. Mellor recommended that the whole of the Far East Rand be prospected and proved before heavy expenditure in equipment or in working is incurred. At the last meeting of the Government Commission the Government engineer stated that if the Government went in for prospecting by sinking shafts before calling for tenders it might is well go in for State mining. He also stated that in ten years' time he estimated that 27 of the existing producing mines will have been exhausted. As it takes eight to ten years to sink, develop, and equip these Far East Rand mining areas, it is evident that in a few years the output of the Rand must come to a standstill, if it does not decline, before some of these Far East Rand areas have become producing mines.

TORONTO, CANADA

Important Findings of the Provincial Nickel Commission.—Large Ore Reserves Available in Canada.—Plans for Reduction and Refining.

The report of the Ontario Nickel Commission, which has been delayed for some time, owing to the illness of the chairman, George T. Holloway, of London, was presented to the Legislature on March 26. It is a document of 800 pages and covers practically every phase of the question. The commis-

sioners, or some of them, have visited the mines and works of the various nickel-producing countries in addition to making exhaustive investigations as to the present condition and possibilities of the Canadian nickel industry. The conclusion is that nickel can be economically refined in Ontario, and that owing to the extent and richness of the nickel deposits, the Province offers better facilities for the production of nickel at a low cost than any other country and has little to fear from competition. They report that while any of the processes now in use for refining could be successfully worked in Ontario, the most satisfactory method will be the electrolytic, in view of the facts that no chemicals are required, that it effects a greater saving of the precious metals, and that electric power is cheap and abundant. It is noted that the projected refinery of the British America Nickel Corporation, which will probably be placed near the Murray mine, in the Sudbury district, will use the electrolytic or Hybinette process. The drastic proposals to secure the refining of the entire Ontario output of nickel within the Province finds no favor with the Commission. They point out that the Provisional Legislature has no power to accomplish this directly by prohibiting the export of the ore, or imposing an export-tax, and that there is a grave doubt as to whether it would have authority to impose differential taxation in favor of the home-manufactured product. Government ownership would be impracticable, as it would cost about $100,000,000 to expropriate the deposits and plants of the Sudbury district. The view is expressed that the completion and operation of the two plants now arranged for will go far toward a solution of the question of domestic production, and that the output of these refineries, together with the nickel now produced in Britain from Sudbury matte, will fully meet the requirements of the British Empire. The geology and mineralogy of the Sudbury nickel deposits is fully described, and the extent of the proved ore-reserves is estimated at 70,000,000 tons, while, if the probable and possible ore were included, there would be an aggregate of 150,000,000 tons. The present method of taxation on net profits is regarded as just and equitable and any change should be an increase of the rate rather than a change in principle, but the present rate of 3% should not be raised above 5%. The method in vogue of ascertaining the value of nickel-copper ore at the pits is not considered satisfactory. The profits to be taxed, it is recommended, should be fixed on the basis of the value of the refined product, less deductions, as at present, and such further deductions for the cost of actual treatment as can be established by the owner to the satisfaction of the mine assessor. The report is silent as to the charge that the International company has escaped with a very light tax contribution in the past, and contains no suggestion for the retro-active taxation measure promised by Hon. G. Howard Ferguson, Minister of Mines.

The 4-weekly statement of the Hollinger Consolidated for the period ended February 25, shows gross profits of $210,868, from the treatment of 48,252 tons of ore of the average value of $8.45 per ton, at a working cost of $3.96 per ton milled. The mill ran 83% of the possible running time. Exaggerated statements of a very rich find on the Acme property that have been published have been denied by the management. It appears, however, that a vein on the 425-ft. level has been yielding some exceptionally rich ore, but the discovery is not a new one. At the McIntyre the main vein has been driven on for 900 ft. on the 1000-ft. level, the drift being in ore all the way. Cross-cutting at intervals shows that the orebody averages 28 ft. wide. The drift will be continued toward the Plenaurum property, which is under option to the McIntyre, and explorations made. The shaft of the Jupiter, now down about 500 ft., is being continued to the 1000-ft. level. A diamond-drill hole on the east end of the Jupiter has cut a 5-ft. vein of high-grade ore at a depth of 735 ft. Harry Darling has resigned as manager of the Dome Lake and has gone to California on behalf of the Crown Reserve Company.

Now that Kirkland Lake district is obtaining a supply of electric-power, development is making rapid progress. The annual report of the Tough-Oakes shows earnings from production amounting to $707,114 from the treatment of 39,863 tons of ore. Dividends amounting to $365,235 were paid, and operating expenses were $328,066. The deficit was increased to $104,567. This unsatisfactory condition was due to the curtailment of operations for want of power. Some rich ore has been developed at the Hunton-Kirkland, where a vein 7 ft. wide has been stripped for 200 ft. The shaft is in high-grade ore for 18 ft. At the Wright-Hargraves, No. 2 shaft has reached the 100-ft. level and will be continued to the depth of 300 ft. It is in high-grade ore. At the Kirkland Lake, the vein at the 500-ft. level is stated to be from 20 to 30 ft. wide and richer than on the upper levels. The shaft is being put down to the 600-ft. level.

The main shaft of the Temiskaming has reached the 1600-ft. level and has been connected with the workings of the Beaver.

CRIPPLE CREEK, COLORADO

THE DISTRICT NOW PRODUCING OVER A MILLION A MONTH.—DEEP MINING FROM THE ROOSEVELT TUNNEL.

The production from the mines of the Cripple Creek district for the month of March, as reported by the mills and smelters, was as follows:

	Tons	Value per ton	Total value
Golden Cycle M. & R. Co.	34,000	$20.00	$680,000.00
Portland G. M. Co.	10,367	17.08	177,068.36
Smelters, Denver and Pueblo	2,500	55.00	137,500.00
Portland, Victor	18,600	2.34	43,524.00
Isabella Mines Co.	1,600	3.00	4,800.00
Worcester-Rubie mill	400	2.90	1,160.00
Gross value	67,467		$1,044,052.36

Average value per ton, $15.47.

A new company composed of Chicago and Denver men recently has been organized to operate the properties of the Last Dollar Gold Mining Co. on Bull hill. The new company will be known as the Catherine Gold Mining Co. Charles Walden, of Victor, will be manager.

The Vindicator Gold Mining Co. has men at work constructing dams in Grassy gulch to impound the tailing from the new flotation-plant. Some of the slime has already escaped into West Beaver creek and ranchers in that vicinity are contemplating damage suits against the company to force the latter to keep its tailing where it belongs.

Negotiations are under way between the Raven & Beacon Hill Gold Mining Co. and the Elkton Con. M. & M. Co., looking to the exploitation of the estate of the Raven & Beacon Hill G. M. Co. from the Roosevelt-tunnel level of the Elkton shaft.

Dividend 54 of the Cresson Con. G. M. & Dev. Co. will be paid April 10. The amount of the dividend is $122,000 and the total paid by the company will be $4,709,162.56.

It is expected by the middle of April the new Independence mill of the Portland Gold Mining Co. will resume the treatment of low-grade ores.

On March 26 the American Smelting & Refining Co. officially announced a reduction in treatment-rates on ores from the Cripple Creek district. The new rates become effective immediately, and are as follows:

Ore to the value of $30 per ton, $5, including freight and treatment.

Ore of value between $30 to $40 per ton, $5.50, including freight and treatment.

Ore of a value in excess of $40 per ton, $6, including freight and treatment. This means a reduction of from $1.50 to $2 per ton.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

(Special Correspondence.)—Forty-five men are blocking out ore in the Willow Creek district for the early spring run and teams are busy hauling mining timbers and supplies to the mines; recently the Talkeetna Mining Co. landed its new mill at the mines.——The new town Wassilla, on the main line of the Government railroad, will be the supply station for the Willow Creek mining district the coming season, being only 15 miles from the mines.

Knik, March 1.

Tolavana

At the beginning of its third year this camp is showing great activity. "From No. 2 Below Discovery, to No. 21 Above, the pay-channel has been proved on the third-tier bench, right limit of Livengood creek, and there are about 50 plants hoisting pay-gravel. There is also some work being done on creek-claims, on the upper end of the flats, Below Discovery, the Keystone drill is again in operation after recovering the bit which was stuck 140 ft. from the surface and which had to be dug out. Pay has been found on all of the left-limit tributaries of Livengood creek from Good-luck gulch, near the head to Lillian creek at the lower end, with Amie, Gertrude, and Ruth creeks between—five creeks in all. Considerable prospecting is also being done on Goldstream and other tributaries of Mike Hess creek, where good prospects are being found, but so far no pay has been discovered. Across the ridge, on the Tolovana river, right-limit, is Olive creek, which has been producing the past two seasons, but will be worked more extensively this season, as Jim Hudson has recently discovered pay-gravel 40 ft. thick. The next creek up-stream is Esther, where pay has also recently been found. Near the heads of Ruth, Olive, and Lillian creeks, C. E. Lang and C. A. Frank are developing a group of lode-claims. They have traced the lode over a mile and get good pannings—some of them high—across a width of 600 to 700 ft., but so far they have not found either wall. All things considered, the district looks good and there is still room for a large increase in its size, as many of the adjacent creeks that show good prospects have by no means been thoroughly prospected.

ARIZONA

Mohave County

(Special Correspondence.)—Negotiations are under way for a consolidation of the Big Jim and Tom Reed mines, or the purchase of the former by the latter on a basis of exchange of stock. There has been some ill feeling between the two companies and some talk of extra-lateral rights on the part of the Tom Reed. It is said, however, that an agreement has been reached to arbitrate the apex-claims if a consolidation is not effected.

Ore assaying $4.90 to $13.60 per ton across 6 ft. has been struck in the Telluride property at a depth of 535 ft. On the level 60 ft. above, the vein is practically barren. The shaft is being sunk to 600 ft. where still better ore is expected. The property is on the south side of the easterly end of the Tom Reed mine, where ore has been developed for 1100 ft. J. H. McIver, who opened-up the United Eastern, is in charge of operations.——The United Eastern gives the following as the production of that mine for January and February: The mill started January 4. Inclement weather hindered work and resulted in a low extraction, 92.8% for the month; 3800 tons of ore was milled of an average value of $21.86 per ton, with a gross recovery of $83,089.58. Conditions improved in February, and the extraction was 95.2% from 5383 tons, averaging $22.33 per ton, realizing $120,176.36. Unofficial reports give the daily output for March at $5500.——The Adams east drift on the 400-ft. level is in low-grade ore 210 ft. from the main cross-cut. The company expected to cut the downward extension of an ore-shoot at about 220 ft.——Connection has been made between the Big Jim and the Aztec workings on the Tom Reed at a depth of 400 ft. Both companies are in ore of excellent grade at the point of connection. The foot-wall drift on the 600-ft. level of the Big Jim is in 150 ft. The average for the first 70 ft. was $18.14. Superintendent Keating reports the same grade of ore throughout. At 100 ft. in the drift a cross-cut was driven to the hanging wall. The vein is 35 ft. wide.——The annual stockholders' meeting of the Tom Reed Gold Mines Co. has been postponed from March 31 to April 30. It is understood that important matters, not yet settled, will be taken up by the directors before the date of the meeting. Machinery for the addition to the mill is being installed and the company expects to have the plant in operation within thirty days.

Oatman, April 2.

(Special Correspondence.)—Secretary Warmbath, of the Big Jim Gold Mining Co. has wired as follows: "United Eastern this afternoon bought the Big Jim and Monarch claims of the Big Jim company, paying for the same with United Eastern treasury stock. Full details will be given as soon as the deal is completed." The United Eastern report of December 11, 1916, showed 300,000 shares in the treasury. The company is producing over $150,000 monthly. Big Jim is credited with ore estimated at $2,500,000 exclusive of that on the 600-ft. level recently opened. Both mines are on the same lode, though one mile apart.

Oatman, April 4.

(Special Correspondence.)—An experienced flotation-man has been employed by the United States Smelting, Refining & Mining Co., stationed at the company's smelter at Needles. He is engaged in experimental work on ore from the company's Gold Road mine, five tons of ore having been sent to the smelter last week. The mine is equipped with a 300-ton cyanide-mill, which has been idle since July 1, 1916.

Oatman, April 3.

Yuma County

The steamer 'Iola' recently brought the first consignment of ore from the mines of the Western Arizona Copper Co. and unloaded it on the river bank near the Santa Fe railroad bridge at Parker. The ore carries about 12% copper and $4 gold per ton. This ore was sorted from the run-of-mine rock taken out in driving an adit, which was in 60 ft. April 1. The adit follows the foot-wall of a vein, shown to be 20 ft. wide by cross-cutting. It is expected regular shipments will be made.——The Copper Basin shaft is down 300 ft. Sulphide copper ore was found at 90 ft. depth, where the first sign of water appeared. Since then the influx of water has steadily increased and now amounts to 2500 gal. daily. Pumps have been ordered.——A churn-drill for the Mammon has arrived at the mine, and will be employed in prospecting the ground before the site for the proposed 3-compartment shaft is chosen. There is stated to be 20,000 tons of ore on the dumps, and shipments are to be made.

CALIFORNIA

Development work in the California oilfields during the first quarter of 1917, as shown by the reports of the State Mining Bureau, amounts to twice that done during the corresponding period last year. This year there have been 287 new wells started. The other work passed on by the Bureau engineers, such as tests of water shut-off, deepening, re-drilling, and abandoning wells, has increased in like proportion. Statistics indicate that the present rate of production for the average well is sligtly lower than it was during the past year, which, in conjunction with the constantly decreasing stock of stored oil indicates no immediate cessation of drilling activity. The price of crude oil at the wells averages about 40% higher than it was a year ago. The cost of material and labor in the fields has also advanced nearly as much. The report for the week ended March 31 shows 17 new wells, 27 tests of water shut-off, 25 deepening or re-drilling, and 6 abandoned.

El Dorado County

Garden Valley. The Cincinnati mine, 1½ miles south of Garden Valley, has been under development for some time by San Francisco and Berkeley owners. An adit is now in 200 ft. on the foot-wall of the vein. The widest part of the vein from which assay-samples were taken was 60 ft. between walls. The average value of the ore was $1.65 gold per ton. A width of 12 ft. gave average returns of $5.17 free gold, and 2 ft. on the hanging wall averaged $114.19. A cross-cut at the 150-ft. station in the tunnel shows 16 ft. of good average pay-ore; and a cross-cut at the 200-ft. station, at a vertical depth of 80 ft., shows a body of dry decomposed yellowish ore 11 ft. wide that averages $8 free gold per ton and also contains a fair average of high-grade sulphides. The vein extends 2000 ft. on the Cincinnati, running east-west across the formation.

Inyo County

Work is moving along on the plant of the California Alkali Co., at the south-west corner of Owens lake, says the Inyo *Register*. The frame-work of some of the buildings is up. The plant will have excellent shipping facilities, its nearness to the railroad avoiding the transshipment necessary for the plants situated on the east side of the lake. The Foundation Company, of San Francisco, has the contract. A fourth plant is a possibility. Porfirio P. Garcia, of San Antonio, Texas, was recently at the lake with assayers and chemists, and shipped a carload of the alkaline deposit and a quantity of lake water to an Eastern point for analyses.

Mariposa County

Rudolph Schweitzer and a partner, who for two years have been working a mine on the Mariposa Grant, the property of the Mariposa Mining & Commercial Co., report finding very rich gold ore in their lease, and that to keep the discovery a secret and secure, on April 3 they placed a heavy door in the tunnel. The following morning when the men returned to work the ore had all been stolen. Mr. Schweitzer says that not less than a ton of the quartz, worth $10 per pound, had been taken, thus losing $20,000.

Mono County

(Special Correspondence.)—The Masonic district is again displaying activity after several years of quiet, with the outlook favorable for a brisk summer. At the Serita, operated by the Serita Mining Co., controlled by Stall Bros., 60 to 75 men are constantly employed. Ore is sent to the Pittsburg-Liberty 10-stamp mill, which was acquired by the Serita Co. last year and tube-mills added to the cyanide department. Rich ore is said to have been found recently in the east vein. This property, composed of the Serita, Serita No. 1, Bull Moose, and Friday claims, has yielded well in the past year. Mine and mill equipment is operated by electricity, the power-plant being owned by the company.

John D. Martin and associates of San Francisco are working the New York group, adjoining the Serita. The main shaft is down 190 ft., but work is chiefly confined to the 150-ft. level, where a wide vein of good ore is exposed. The pump is operated by a gasoline-engine. The same people have taken a bond on the Snowshoe claim.

The Lakeview property has been taken under bond by E. C. Easton, of San Francisco, and preparations have been made for vigorous work.——Conway & Fredericks, formerly of Sweetwater, Nevada, are working the Pittsburg-Liberty under bond and lease. Ore indications are reported encouraging, and it is planned to carry the workings deeper in hope of again finding the main orebody.

The Masonic Mines Association has arranged for work on a large group of claims, under the management of George Burris. A double-compartment shaft will be sunk 200 ft. to intersect the Masonic lode, which is believed to pass through the property.——The Sally Degneer claim is being worked on lease by Hayes brothers.

Masonic, April 7.

Placer County

(Special Correspondence.)—Recent development work on the Morgan asbestos mine, at Lover's Leap, on the middle fork of American river, has resulted in the discovery of a large vein of long fibre (slip-fibre) asbestos. The company is to be re-organized and suitable machinery provided to prepare the mineral for market. Mr. Werner is in chrage.

Towle, March 26.

Shasta County

(Special Correspondence.)—The Bully Hill group of copper properties, near De Lamar, is being re-opened by Eastern capitalists, under the management of Walter Arnstein. The group comprises 23 claims. The development has been mostly in the Bully Hill, Winthrop, Rising Star, and Baxter mines. The Bully Hill has been opened by a 1000-ft. adit and 800-ft. three-compartment shaft, the latter sunk from the adit 900 ft. from the portal. This shaft is equipped with a double-drum electric hoist and two electric plunger-pumps with a capacity of 700 gal. of water per minute. The Rising Star mine has been opened to a depth of 800 ft. by a three-compartment shaft and is well equipped. When last operated, six years ago, the property was producing approximately 5,000,000 lb. of copper per annum. Work was discontinued because of the high zinc content of the ore, and also trouble with Federal authorities over smelter-smoke. With the ordinary blast-furnace smelting, Captain De Lamar estimated the daily loss by waste of the zinc at approximately $1000. The company recently perfected an electrolytic process for extracting the zinc, leaving copper, gold, and silver to be recovered by smelting. The zinc-process is embodied in the $350,000 electrolytic plant recently completed near Kennett by the Mammoth Copper Co. The old smelter has two blast-furnaces, of 350 to 400 tons daily capacity, McDougall roasters, a reverberatory-furnace, and converting-plant. It is reported that the new management plans the building of an electrolytic zinc-plant, and that flotation equipment may also be provided.

The Arps Copper Co. has started work near the Baxter mine of the Bully Hill group. In addition to the copper-bearing ore, silver ore has been lately discovered, and plans are being made to open the mine to greater depth and install more equipment. Superintendent Henry states that shipments of selected ore will be made regularly to the Mammoth smelter until the company installs a flotation-equipment.

A lower adit is being driven at the Shasta Belmont, near the Arps, and the management expects to reach the main orebody within 100 ft. Ore will be shipped to the Mammoth smelter until the company can provide a flotation-unit. Negotiations are proceeding for the bonding of the property to a company of Eastern people.

It is stated at Ingot that operations will be resumed at the

Afterthought copper mine within 60 days, and that plans have been arranged for construction of a large flotation-plant, to cost approximately $100,000. The railroad from Bella Vista to Anderson is being placed in shape for shipment of ore and supplies. Miners have been re-timbering the workings. Leaching-equipment will probably be provided to handle the zinc-bearing ores, of which a large tonnage is exposed.

Reading, April 6.

SISKIYOU COUNTY

(Special Correspondence.)—The Mason Valley Mines Co. has constructed a camp at the Gray Eagle property, near Happy Camp, improved the roads, and otherwise arranged for large-scale work. Mine developments are said to be satisfactory, and shipments will be made this spring to the smelter near Thompson, Nevada. It is stated the company plans to erect flotation-equipment at the mine, which contains upward of 4,000,000 tons of ore. Several nearby properties have been taken under option and are receiving attention.

Recent reports that the Blue Ledge Copper Co. was planning immediate work at its mines in the northern part of this county appears to be erroneous. Until a railroad is extended into that district transportation problems heavily handicap production. A line has been surveyed to Medford, Oregon, and may be built this summer. Should this be done the Blue Ledge district promises to become one of the most active copper regions of the West, as large deposits of fair-grade ore has been discovered there.

Yreka, April 5.

TUOLUMNE COUNTY

(Special Correspondence.)—Taxes for seven years, amounting to $6000 on the Clio group of mines, were paid and title to the property passed to Minnie Grauer, of Oakland. The transfer was first made by the Ora Mining Co. to Otto G. Freyermuth, of San Francisco, who deeded the property to M. Grauer. It is said that operations will be resumed under the direction of Robert Grauer, who has spent much time in recent years in exploring the property.

The Rawhide mine will soon have been unwatered to the bottom. While the water was being pumped out, levels were being cleaned and repaired, and as a result exploration and mining work will not much longer be delayed.

It is reported that good ore has been discovered in the Confidence mine, 12 miles east of Sonora, operated by the Confidence Mines Corporation, recently organized under the laws of Virginia. The mine was re-opened during the latter part of last year, and has been equipped with machinery for development.

A gasoline-engine and an air-compressor have been installed at the mine on the Soulsby ranch being operated by Harris, Moore & Baker. The stoping from the rich shoot lately found will begin soon.

A vein 8 to 16 ft. wide, just west of Sonora, is being prospected by C. E. Rives. Several shafts, the deepest 125 ft., have been sunk on the vein and good ore has been found in each. At the south end, where the vein is 16 ft., it is stated assays show an average of $5.70 per ton. A streak a few inches wide goes as hign as $96 per ton. About the middle of the property the vein is 8 ft. wide and the assays run up to $16. On the north end, at a depth of 20 ft., there is 6 ft. of quartz. No assays have been made of the ore at this point.

Work has been resumed at the Addis mine, near Confidence.

Mining for chrome and magnesite is becoming an important industry near Chinese. All the chrome ore that can be mined on the property of Simon Goudge and George Egling during a period of 12 months has been contracted for, and shipments are being made from other properties also.

Sonora, April 4.

COLORADO

A meeting of all tungsten operators and others concerned in the industry will be held in Denver in the rooms of the State Mining Commission, for the purpose of furthering interest in the bill that was introduced by Congressman Timberlake, providing for a tariff on tungsten and which he now has support enough to pass should an extra session of Congress be called. According to word from Congressman Timberlake, the bill now has the support of California, Arizona, Pennsylvania, New Mexico, and New York, besides a scattered support from other States.

The tungsten miners declare they will be forced to close their mines should the War end and the embargo on shipping be declared off. The industry is now producing thousands for Western States, they say, and should be protected until the place is reached where the mines of this country can compete in efficiency and low-cost production with other countries. The tariff asked by Congressman Timberlake's bill is $10 per ton on the ore and $1.25 per pound on the finished product. This tariff, they assert, would enable them to compete with foreign products and keep open their mines, even though the present price of tungsten were reduced materially.

Naturally, in the event that the United States takes the sweeping steps planned for preparedness, tungsten will become one of the most important products in the entire West and the tungsten miners declare their properties are capable of wide development.

The meeting of the operators will be held in a few weeks.

IDAHO

SHOSHONE COUNTY

Greater milling capacity than was first contemplated and an expenditure of $200,000 or more is proposed by the Nabob Consolidated Mining Co., at Wallace, according to H. T. Irvine. The intention to erect a concentrating-plant having a capacity of 200 tons or more daily was announced several weeks ago. It was stated then that Manager Beaudry of the Stewart company was gathering a large quantity of machinery and materials of which use would be made promptly after the transfer in equipping the Nabob property.

It is probable that a sorting-plant will be established at once on the Denver section of the Nabob property to take advantage of current prices for the metals, says the *Spokesman Review*. The concentrating mill should be in operation within three months. In the meantime an important output can be made from the new workings, while development of the resources there, already large, is proceeding. An advance of the lower Nabob adit to the Denver claim, which would be penetrated at great depth, is among the projects.

A party of 15 students and instructors is visiting the Bunker Hill & Sullivan mine, mill, and smelter at Kellogg, and several of the mines and mills in the neighborhood of Wallace and Mullan. This is the annual spring excursion of the college of mines of the University of Washington.

MISSOURI

JASPER COUNTY

The production of lead, blende, and calamine of the zinc-lead mines of south-west Missouri and the adjacent field in Kansas and Oklahoma in 1916 was $34,961,993, and the total production of the region since its discovery has reached $328,453,558. In 1915 the production was $26,038,650.

MONTANA

FERGUS COUNTY

(Special Correspondence.)—At Hanover 150 men have been employed all winter by the Three Forks Portland Cement Co. A 24-room hotel, large office building, and two apartment-houses have been finished and work has started on a number of store-buildings. A reservoir and water-system to supply water to the town and the plant are nearly completed. A complete machine-shop and store-room is about finished and will

be equipped with machinery in time to hasten construction of the cement-mill on which work will be started at once. Besides the deposits of limestone, shale, and gypsum near Hanover, there is plenty of sand-rock, brick-clay, and gravel for construction work.

There is still much snow in the mountains and many prospectors and miners are waiting for the snow to melt before reopening their properties.

In the Little Belt mountains zinc ore is being produced regularly at the Neihart mines and shipped to Great Falls. The Butte & Great Falls is among the shippers. Some copper and zinc ore is also being produced on Wolf creek, where a dozen men have been doing development work all winter. Shipments of ore are expected to be made from some of the old mines in the Castle mountains this summer.

In the Cumberland mine, at Maiden, the lessees have been sinking a shaft. Some good ore has been found during this development, but a strong flow of water was encountered that has flooded the mine. A pump will be installed as soon as possible and a drift will be run on the ore as soon as the water can be controlled.

Lewistown, April 3.

NEVADA

Clark County

(Special Correspondence.)—The main cross-cut tunnel at the Yellow Pine mine has reached a point below the ore deposit on the 300 north sub-level, 1000 ft. from the portal. Connections have been established and all ore from the upper levels is now handled through the tunnel. The company has resumed production and plans to increase its output, also to ship from the Charleston property. Fred A. Hale, Jr., is manager.

The Hoosier lead-zinc mine has been sold to E. S. Armstrong and associates of Pasadena, California, for approximately $40,000 by Harry Josephs and Claudia Morris, of Salt Lake City. It is planned to install a dry-concentrating plant, as a large tonnage of good ore is blocked out. N. Touroff has been appointed superintendent.

Ore running high in copper and cobalt has been uncovered at a depth of 60 ft. in the Red Streak claim, owned by N. B. Price and worked under lease by Smith Bros. The discovery was made in a winze from the old adit. A new lower adit will be driven. The Yellow Pine Co. has leased its Porter and Prospect claims, in the southern end of the district, to R. C. Lochridge, who has started work with Phil Ryan in charge. The claims yielded some rich lead-zinc ore ten years ago, but have been given little attention of late.

C. L. Hyde, of San Diego, California, has started work on the Milford group and expects to begin shipping to custom plants by way of Roach, the nearest railroad point. The Milford adjoins the Ingomar and has produced much shipping ore. ——Important discoveries have been reported in the past week from the Boss Extension, Ironsides, and Paymaster properties.

Goodsprings, April 4.

Esmeralda County

(Special Correspondence.)—The flotation-plant of the Goldfield Consolidated is extracting 90% of the gold content of ore, and practically all the copper, according to general manager J. W. Hutchinson. The copper concentrate is sent to smelters, and the gold-silver concentrate is treated in the local refinery of the company. Hereafter the company plans to treat 500 tons of oxidized ore daily with cyanide, and 500 tons of sulphide by flotation. In addition to the Consolidated product, considerable custom ore will be handled, a contract having been recently signed to treat 100 tons daily for the Atlanta Co. It is officially stated that ore conditions in the Aurora Consolidated property are improving, and that this mine is earning profits. Several properties are being examined with a view to their purchase.

Ore shipments from the Atlanta in February totaled 250 tons, with returns defraying all operating costs. The ore was drawn from the 1750-ft. level of the Merger shaft, where a 5-ft. vein of $30 smelting ore is under development. It is intended gradually to increase the output of smelting ore, and to start the delivery of 100 tons of $15 to $20 ore per day to the Goldfield Consolidated flotation-plant.

Control of the Manhattan Mustang mine, at Manhattan, has been obtained by L. K. Koontz of Goldfield, and his Nevada and Eastern associates. Work on company account will soon start. The Train-Chase lease has been operating on the Mustang for two years, in which time $35,000 has been extracted. The lease is well equipped and plans for work on a broader scale have been considered. The Koontz people are heavily interested in the Big Four and Morning Glory, two prominent Manhattan mines.

The Nevada Douglas Copper Co. is shipping three carloads of ore daily to smelters, from which about $60,000 per month net is said to be realized. Capacity of the leaching-plant is being forced to 250 tons per day, the ore treated averaging close to 3%. The output of smelting ore will be increased as soon as the second furnace of the Mason Valley smelter is blown in.

Goldfield, April 8.

(Special Correspondence.)—The Goldfield Consolidated company reports for February as follows: Ore milled 21,000 tons, for $19,220.98. Development work, 1698 ft. at a cost of $5.53 per foot.

The operating costs were as follows:

	Per ton ore handled	Per ton total ore
Mining:		
Stoping	$ 2.503	
Development	23.396	
Total mining	$ 2.921	$2.787
Leasing expense	9.741	0.050
Dump moving	0.508	0.019
Tailing dump moving	0.135	.....
Transportation	0.086	0.086
Milling	2.274	2.274
Marketing	0.029	0.029
General expense	0.414	0.414
Bullion tax	0.028	0.028
Filter royalty	0.050	0.050
Flotation royalty	0.057	0.057
Surface	0.064	0.064
Total operating costs		$5.858
Miscellaneous earnings		0.113
Net operating costs		$5.745
Construction		.....
Net costs		$5.745

During February, lessees produced 108 dry tons of ore having a gross value of $2696.02, of which the company received $1531.16.

Goldfield, April 5.

Humboldt County

(Special Correspondence.)—The contract for the 300-ton mill of the Rochester Combined Mines Co. has been let to K. Freitag, 1008 Hobart building, San Francisco, who will have charge of mill construction. J. W. Wilkey is general manager for the Combined Mines Co.——The capacity of the Packard mill will be increased to 150, and possibly 200 tons, daily before July. Jay A. Carpenter is in charge of the property.

The Nanzel Crown Point Mining Co. will begin construction of a 100-ton mill about May 1. It is reported that K. Freitag is to have the design of this mill. The office of the company is at Rochester.

Lower Rochester, March 26.

Lyon County

A 600-ton sampler will be built at Hazen by the Western Ore Purchasing Co. to care for the large ore output of the State. F. M. Manson, manager for the company, states that plans are being considered for building the new plant. The company is now operating a 300-ton sampler at Hazen and the new plant will give the company a 900-ton daily capacity. The sampler will be equipped to handle all kinds of ore.

Washoe County

(Special Correspondence.)—The Standard Metals Co. of Reno is sinking a shaft in this county on a vein containing good value in copper and silver. The shaft, which is vertical, is down 200 ft., and it is expected that the vein will be cut in 50 ft. more, when a station will be cut, and a drift started. Sinking will then be continued. A jack-head pump was placed in the shaft some time since, and for a while it handled the water readily, but lately the inflow of water has increased and the pump now is holding it until a heavier plant can be secured. The mine makes 100 gal. of water per minute, though a much larger quantity is anticipated in greater depth. The formation is grano-diorite and meta-andesite. The work is under the direction of John R. Meaker.

Reno, March 26.

NEW MEXICO

Grant County

(Special Correspondence.)—The Calumet-New Mexico Mining Co. did 600 ft. of work during 1916, and has increased the working-force since the first of the year. Most of the work has been in or near the vein on the 200-ft. level, where a drift was run along 2½ ft. of ore the most of which carries zinc, lead, silver, and gold to the value of $75 to $100 per ton. It is intended to build a mill the coming summer. At present selected ore is being shipped.

Silver City, April 4.

(Special Correspondence.)—Carlisle Mining Co., at Steeplerock, reports the Pilot mill operating at a capacity of 75 tons daily. The mill-heads average about 80c. per ton gold, 2 oz. silver, 1.25% copper, 7.5% lead, and 7% zinc. The lead and copper recovery is excellent, that of the zinc yet to be determined. The mill is producing regularly several tons of copper-lead concentrate, which assays $8 per ton gold, 12 oz. silver, 10% copper, 50% lead, and 7% zinc. The property is now on an earning basis.

Steeplerock, April 7.

Socorro County

(Special Correspondence.)—E. L. Starr, representing Dowst & Co., Inc., of New York, has made an inspection of the camp preliminary to underwriting a large block of the new securities issued by The Oaks Company.

The Mogollon Mines Co. is developing its 900-ft. level both west and east. The mill, on the night of March 29, was threatened by fire, started by a short-circuit in an electric-solution heater.

The Oaks Co. is increasing its crew at the Maud S. mine and is making a shipment of ore to a custom-mill. Work continues at both the Clifton and Eberle properties.

D. E. Bearup is meeting encouraging results in the development of his Eureka group in the west part of the district, both milling and high-grade shipping-ore being produced.

The local power interests of B. W. Hills and associates have been taken under option by Charles E. Stewart of New York, who proposes to complete the hydro-electric installation.

Mogollon, April 6.

NORTH CAROLINA

Buncombe County

(Special Correspondence.)—At Sylva and Spruce Pine, the Harris Clay Co. operates kaolin mines successfully and is said to be making money. C. J. Harris, of Sylva, North Carolina, is the owner of the enterprise. At Hewitts, Frank Hewitt, of Asheville, has mined talc for a number of years with success but his mines are reported to be so flooded with water that they cannot be operated longer successfully.——J. F. Conroy, of Sylva, is promoting some zinc and iron properties in East Tennessee.——The Carolina Barytes Co., of Stackhouse, and G. Anson Betts, have been interested in barytes mining at Stackhouse, but neither of these mines is in operation, though B. W. Gahagan is now operating his mines and shipping barytes.

The Shut-In Iron Mines, Inc., owned by G. Anson Betts, has just completed a hydraulic plant at Hot Springs, for the mining of brown iron ore.——The Marble Mining Co., of Marble, also owned by Mr. Betts, is installing a plant for the mining of iron ore.——The Gardner Hill Gold & Copper mine, near Greensboro, has been opened after an idleness of over 50 years. years.

Asheville, March 26.

OREGON

Baker County

The Ben Harrison mine, 28 miles by road from Sumpter, is reported sold to E. H. Dewey, of Nampa, Idaho. The mine is near the head of Clear creek, at an elevation of 6500 ft. The vein has been stoped for 400 ft. above the 200-ft. level, and is said to have produced $300,000. The ore is a mixture of sulphides in quartz—pyrite, chalcopyrite, stibnite, and sphalerite, with silver sulphides, and gold. The value is uneven in its distribution. The machinery equipment consists of a gyratory-crusher, 20 stamps, a tube-mill, classifier, and Isbell concentrators.

Jackson County

(Special Correspondence.)—The Cheney, Simmons, Ray and Haff group of quartz claims, three miles north-east of this city, have been operated by H. A. Ray and G. L. Haff the last two years. They were the owners of these properties excepting the Simmons and Cheney claims, which they operated under a lease from the owners. This property has been sold to Sacramento, California, people, who have been represented here by J. W. Davies, of that city. The consideration is stated to be $80,000. The vein contains quartz carrying pyrite; this lode-matter contains gold and silver to the value of $3 per ton. The high-grade ore occurs in boulders, at a depth of 80 to 100 ft. Sulphide ore begins to appear at 160 ft., and the vein is 5 ft. wide at 225 ft. depth. The hanging wall is a slate, and the foot-wall is limestone. The greatest depth attained on this vein is 600 ft., where it is 25 ft. wide. The discovery, in March 1916, of scheelite with the gold ore in this mine was announced. The mineral is a small stringer with quartz. Samples have been taken that run as high as 40% tungstic acid, but it is claimed by the management that the vein as a whole runs less than 2%. The discoverers of this vein, William Cox and George Lyman, two local miners, in 1896 mined a pay-shoot that netted them $8000 in gold. This shoot occurred where a fault displaced the vein at a depth of 35 ft. Two years later they disposed of the claim to Elisha Ray, of this city, who began operations by driving 16 ft. and striking the continuation of the vein and removing a pay-shoot containing $4800, at a depth of 25 ft. This claim has been owned and operated by the Ray family since that time, and they have realized various sums while developing the vein. Most of the permanent development work is on the Simmons and Cheney claims, which are generally known as the Sylvanite mine. The Sylvanite lessors, who were Canadians, fully equipped these two properties several years ago with a modern mill, hoists, and other machinery, all operated by electric power. Later, financial troubles caused the suspension of their operations, and the machinery was sold in the courts to satisfy their creditors. The new owners will start an adit at the foot of the hill and extend it to the vein, 1200 ft. This will give them a depth of 500 ft. Operations will begin at once with new ma-

chinery, operated by electric power. George Stone, recently of Colorado, will be general manager and G. L. Haff will be superintendent.

Gold Hill, April 3.

SOUTH DAKOTA

PENNINGTON COUNTY

Preliminary arrangements for starting work on the pipeline which will carry the water to the new hydro-electric generating plant of the Homestake Mining Co., soon to be erected in Spearfish canyon, have been made, says the Lead *Call*. For several days men connected with Frank G. Baum of San Francisco, electrical engineer in charge of the work, have been engaged in arranging for a camp headquarters in the canyon, and William B. Arndt, rock contractor of San Francisco, arrived recently to get his part of the work in progress at the earliest possible date. The Burlington station site at Maurice has been leased and will constitute the general headquarters of the construction people, while the pipeline work is in progress. The Homestake company has also leased the buildings of the Victoria Mining Co., to be used as camp quarters for the various crews of men employed on the job.

Mr. Arndt has the contract for driving one mile of tunnel and probably will be engaged for the entire job of grading, which will be practically all rock work, a distance of nearly 5 miles. The water will be conducted from the dam through a continuous wood-stave pipe, 52 in. diam., to the generating plant, where it will have a pressure of about 500 feet.

WASHINGTON

CHELAN COUNTY

The Lookout Mining & Milling Co. has uncovered a fine body of copper ore on its property in Methow valley, near Twisp.

FERRY COUNTY

(Special Correspondence.)—Since the resumption of operations in the Tom Thumb mine two weeks ago, the output of ore has been 550 tons. During the week ended March 29 the ore shipments from other mines were: Knob Hill, 230 tons, Lone Pine, by the Northport Smelting & Refining Co., 400 tons. The average output of the Knob Hill mine is now 30 tons or more daily. The Lucille Dreyfus mine, that for several years has been idle, is again in operation and putting out ore for shipment. The property is situated near Danville.

CANADA

PORCUPINE. The Hollinger, Acme, and the Consolidated Company (Hollinger Consolidated), has produced to December 31, 1916, $15,466,444 and paid in dividends $7,456,000. The deposits were discovered in 1909 and production began in 1911. The Hollinger output in 1911 was $46,082.

HONDURAS

During 1916 the New York & Honduras Rosario Mining Co., at San Juancito, yielded an average of 150,600 oz. of silver and 1280 oz. of gold per month, from 10,565 tons of ore. The value averaged $125,000. The December output was 11,600 tons for 182,000 oz. of silver and 1550 oz. of gold, valued at $165,000. In 1915 the average monthly yields were 9815 tons, 145,659 oz. of silver, and 1267 oz. of gold, valued at $97,125. Silver in 1915 realized 50.1c. per oz.; in 1916, 66.6 cents.

KOREA

The February clean-up of the Oriental Consolidated mines amounted to $132,232.

TRINIDAD

The Trinidad Leaseholds (Ltd.) of London reports the oil production of the company for February at 4520 tons.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

JULES LABARTHE is at Juneau.

J. M. CALLOW was here this week.

MORTON WEBBER is at Grass Valley.

CHARLES BUTTERS has returned from New York.

GEORGE O. BRADLEY has returned from Salt Lake City.

GEORGE F. BRIDGER has gone to Baguio, Philippine Islands.

W. DEL. BENEDICT has returned from Monterey to San Francisco.

SPENCER C. BROWNE has returned to New York from California.

WALTER G. PERKINS has opened an office at 462 Mills building, San Francisco.

JAMES S. DOUGLAS, manager of the United Verde Extension mine, is at New York.

HERBERT STONE has joined J. M. HYDE and is in the Mills building, San Francisco.

MARK R. LAMB was in Oruro, Bolivia, recently; he expects to reach New York this month.

L. B. SPENCER & Co. have removed their laboratory from Hawthorne to Mina, Nevada.

H. E. DENNIE, is now Western manager for the Imperial Belting Co. at San Francisco.

T. A. RICKARD will deliver the Commencement address at the Colorado School of Mines on May 25.

WALTER KARRI-DAVIES and WILLIAM W. MEIN have opened an office in the Mills building, San Francisco.

J. F. MITCHELL-ROBERTS sails on the 'Tenyo Maru,' leaving San Francisco on April 12, returning to Korea.

T. D. REES, formerly with the Utah Copper Co., has joined the Stimpson Equipment Co. at Salt Lake City.

W. H. SEAGRAVE and W. T. DUNKLE have formed a partnership as consulting engineers at Seattle, Washington.

D. L. H. FORBES, recently construction engineer and metallurgist at the Chuquicamata mine, of the Chile Copper Co., has returned to New York.

FRANK C. LAURIE has been appointed general superintendent for the Freeport and Tampico Fuel-Oil Corporation, with headquarters at Tampico, Mexico.

E. R. JONES, until recently assistant superintendent of the Mass copper mine, has gone to Asbestos, Canada, to take a similar position with the Johns-Manville Company.

JESSE C. PORTER and JOHN B. STEWART are now in charge of the business of the C. L. Constant company of New York, in the National Bank building at Calle Cuba, Havana, Cuba.

FRED F. MELOCHE and STANLEY M. TIFFANY, who have been attending the last semester of the University of Washington, will leave for the north coast region of British Columbia on an exploring and prospecting tour.

HENRY J. GIFFORD is retiring from the superintendency of the Champion Reef mine, in India, and will be succeeded by C. F. HEATHCOTE, formerly manager of the Tasmania gold mine at Beaconsfield, in Tasmania.

F. G. CLAPP, managing geologist of the Associated Geological Engineers, has gone to Arkansas; M. L. FULLER, the other managing geologist, is making new explorations in West Virginia; C. T. GRISWOLD, geological engineer, is in southern Oklahoma; ERNEST MARQUARDT, geological engineer, in in Wyoming; E. B. HOPKINS, geologist, has returned from Mexico to Texas.

THE METAL MARKET

METAL PRICES

San Francisco, April 10

Antimony, cents per pound	24
Electrolytic copper, cents per pound	38
Pig lead, cents per pound	9.25—10.25
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	115
Spelter, cents per pound	12
Tin, cents per pound	50
Zinc-dust, cents per pound	18—20

ORE PRICES

San Francisco, April 10

Antimony, 50% metal, per unit	$2.00
Chrome, 40% and over, f.o.b. cars California, per ton	18.00—20.00
Magnesite, crude, per ton	8.00—10.00
Tungsten, 60% WO_3, per unit	16.50—18.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 50% (under 35% metal not desired)	29.00

Manganese ore, 40 to 45%, sells f.o.b. Chicago at 58c. per unit with a penalty of 50c. per unit for more than 8% silica.

Tungsten: The past week has shown further great activity in the tungsten market, which, however, becomes more and more difficult on account of the many demands by buyers for guarantees against impurities, and only well-known marks that have reached this market continuously of approximately the same quality can be readily sold at the top prices. Other marks can only be sold at concessions, and therefore it will be found that the prices for tungsten ore range, according to degree, from $18 per unit for high-grade wolframite and scheelite down to $16.50 for material that, on account of impurities, has only a limited market. A large amount of business has again been done for home consumption. France and Italy have been in the market. Besides, forward material has had ready buyers and it was impossible to fill an order for 100 tons of spot delivery wolframite, as such a quantity was not available for prompt delivery. The prospects for the market are good and present prices should be maintained.

EASTERN METAL MARKET

(By wire from New York)

April 10.—Copper is weak and dull. Lead remains unchanged at 9.35c. Zinc is slightly lower, at 10.50c. Platinum is unchanged at $105 to $111.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
Apr.	4	34.00	Feb. 27 — 36.00
"	5	34.00	Mch. 6 — 36.29
"	6	34.00	" 13 — 36.25
"	7	33.75	" 20 — 35.87
"	8 Sunday		" 27 — 35.62
"	9	33.75	Apr. 3 — 34.58
"	10	33.50	" 10 — 33.83

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

The disseminated copper mines during February made the following production: Utah Copper, 13,459,829 lb.; Chino Copper, 6,572,106 lb.; Ray Consolidated, 7,177,898 lb.; and Nevada Consolidated, 5,708,214 pounds.

Production by leading copper companies for the first three months of this year compare as follows:

Company	January	February	March
Anaconda	28,250,000	25,000,000	31,300,000
Inspiration	11,600,000	10,250,000	11,100,000
Miami	5,020,370	4,210,780	5,217,903
Old Dominion	3,000,000	2,695,000	3,335,000

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
Apr.	4	74.00	Feb. 27 — 77.37
"	5	73.75	Mch. 6 — 76.50
"	6	73.62	" 13 — 75.06
"	7	73.62	" 20 — 72.91
"	8 Sunday		" 27 — 72.06
"	9	73.62	Apr. 3 — 72.98
"	10	73.75	" 10 — 73.72

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

The Standard Silver-Lead Mining Co. has declared a quarterly dividend of 5c. per share, payable April 15 to stock of record March 31, putting the stock on a 20% annual dividend basis. From September 1915 until December 10, 1916, when last monthly payment was made, the company paid a regular dividend of 2½ c. per month, or 30% per annum.

Heavy buying of silver on United States Government account has played no small part in the recent recovery in price of the white metal.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
Apr.	4	9.35	Feb. 27 — 9.45
"	5	9.35	Mch. 6 — 11.54
"	6	9.35	" 13 — 9.50
"	7	9.35	" 20 — 9.75
"	8 Sunday		" 27 — 9.50
"	9	9.35	Apr. 3 — 9.40
"	10	9.35	" 10 — 9.35

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date		Average week ending	
Apr.	4	10.67	Feb. 27 — 10.70
"	5	10.67	Mch. 6 — 10.85
"	6	10.67	" 13 — 10.87
"	7	10.67	" 20 — 10.69
"	8 Sunday		" 27 — 10.74
"	9	10.67	Apr. 3 — 10.71
"	10	10.50	" 10 — 10.64

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Mch.	13	105.00	Mch. 27 — 120.00
"	20	115.00	Apr. 3 — 115.00
			" 10 — 115.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

There has been considerable business in quicksilver during the past week. The nominal quotation at New York is $120 per flask for California virgin quicksilver, but business has been done at concessions up to $5 per flask below this quotation.

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	....	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

The tin market continues on the advance with difficulties in getting quotations from the other side. Prices have now reached 56½ to 57c. per pound for spot delivery and the prospects are that these high prices will be maintained for some time to come.

ANTIMONY

In New York spot antimony (metal) is scarce and quoted at 35c. This is extraordinary as material now afloat since February and due any time in New York is obtainable at 20c. April-May shipment can be had at 13½ c. per lb., and this wide margin between spot and forward must soon disappear, as it is an unhealthy condition. Needle antimony is offered for forward delivery around 8½ c. per pound, but there has been no business during the past week. Antimony ore remains as scarce as ever and no business is reported though inquiries are in the market from many quarters.

PLATINUM

Platinum remains unchanged at $105 per oz. for soft metal and $111 for hard.

Eastern Metal Market

New York, April 4.

International and national uncertainties continue to dominate the entire metal market and to cause a waiting attitude by all concerned. Until a definite policy is adopted by the Government there can be no clarity to the market nor much activity. Buying is only spasmodic and based on actual needs.

Copper is inactive and weaker with declining prices.

Zinc continues lifeless and stagnant with prices practically unchanged.

Lead is firmer than most of the leading metals but the market is dull and at a standstill.

Tin continues strong and is firmly controlled, though it too is inactive and lower.

Antimony is still scarce and nominally higher.

The absorbing topic in the steel-market is the amount of steel the producers are to sell to the United States Government and particularly the price. There will be no 50% reduction from present levels, as in the copper deal, because cost prices are proportionately much higher and some steel-makers would lose money on such an arrangement. The problem is not a simple one. A steel-plate price of 3c. instead of 6c. would mean a fraction of a cent above cost to a mill paying $35 per ton for basic pig-iron. March exceeded any month since November, 1916, in pig-iron output, the total having been 3,250,757 tons, or 104,862 tons per day, compared with 94,473 tons per day in February. Many steel and pig-iron prices continue to advance.

COPPER

The uncertainty in international and political affairs has halted transactions to such an extent that the market is dull and inactive. No one wants to buy under present conditions. Some re-sale and first-hand metal is being offered daily which, with other influences, has caused a declining tendency. The market is really so heavy that it falls naturally itself. The quotation for spot and early-delivery electrolytic has declined steadily until on Tuesday it had reached 34c., New York. There is no considerable buying for either second or third quarter, despite reports to that effect in the daily press. Second-quarter metal is held at 33 to 34c. It is reported that the United States Government will buy at least 90,000,000 lb. more copper, besides the purchase made in March. It is expected that the same low price of 16.67c. per lb. will prevail. It is pointed out that because of continued success on the Western front the Allies will not make any purchase for the last half before May, anyhow. One prominent dealer is quoted as saying that he would not be surprised to hear of large sales of electrolytic at 25c. for last-half or last-quarter delivery. Exports for March are estimated at 31,250 tons, in the absence of prohibited official returns. The average price of copper for March, as quoted in *The Iron Age*, was 35.85c., New York, for both Lake and electrolytic.

LEAD

Last week, up to March 31, there was a better demand than for some days, but it was spotty, or irregular. Export requirements were good and demand from sheet-lead manufacturers was fair. Total sales for all of last week probably reached 4000 to 5000 tons, most of it for late delivery. Some spot-lead sold at 9.62½c., New York. For early delivery 9c., f.o.b. Chicago, was quoted, with 9c. for Eastern shipment in May. This week the market has been decidedly quiet and buying has halted, influenced probably by national events. The railroad situation has righted itself almost completely so that all anxiety has been eliminated as to arrivals from the West. The quotation yesterday was 9.35c., New York, or 9.15c., St. Louis, for early delivery. If producers have made any arrangement to furnish the United States Government with lead needed for war purposes, the fact has been kept quiet. There is no change in the price of the American Smelting & Refining Co., which is 9c., New York.

TIN

Business in the past week has been almost nothing. The entire market is very dull, influenced by the same important factor that has dominated other markets. On March 28 excessive dullness prevailed, the only business done being about 20 to 25 tons of off-grade metal. On March 29 perhaps 100 tons in all was sold and the demand for spot declined to nearly nothing. Since then the market has been absolutely listless and the present condition could not be any more lifeless than in mid-summer. The effect of recent fairly large arrivals, and the slight demand, have caused a recession in the quotation for spot Straits to 54.25c., New York, yesterday. The London market has eased off to £214 2s. 6d. for spot Straits, which is about £4 lower than a week ago. Arrivals thus far in April are 275 tons with the quantity afloat reported at 2226 tons. In March total American deliveries were 4804 tons, of which 1404 tons came through Pacific ports, the unusual heavy arrivals there being accounted for by the probable selection of the safest routes. The average price for tin in March was 54.38c., New York. Tin in stock and landing on March 31 was 3362 tons.

SPELTER

There has been more activity the last two or three days as to inquiries but very little is reported sold. The market continues dull and stagnant and price changes are insignificant. The quotation for prompt and April prime Western is still 10.50c., St. Louis. For May and June 10.25c. is asked with 10c. quoted for July. The high price of ore continues its influence as a steadier of prices, some producers of spelter having a small margin of profit under present conditions. The first change in 11 weeks in the official price of British spelter was made April 2 by an advance of £8 per ton on both prompt and future deliveries. Zinc ore is reported as having fallen $5 per ton last week to $88.40 for high-grades and $85 for assay-base, 60% zinc.

ANTIMONY

Despite fairly large arrivals of Chinese and Japanese grades the spot market continues nominally high at 36c. with the metal very difficult to obtain. Spot demand at present is small. In futures March shipments hold the centre of the stage at 16 to 16.50c. c.i.f. in bond, New York.

ALUMINUM

The market is uninteresting and quiet with no change. The quotation for early delivery of No. 1 virgin metal, 98 to 99% pure, is 59 to 60c. Some sellers expect the Government to buy soon.

ORES

ANTIMONY. Antimony ore is scarce. While there are considerable inquiries reported no business has been transacted.

MOLYBDENITE. There is little change in the market position. The prices previously quoted are fully maintained but business is impossible to secure as buyers now insist upon guarability of manufacturers to supply old contracts. New business is impossible to secure, as buyers now insist upon guarantees of delivery.

TUNGSTEN. Both the domestic and foreign demand continues excellent. France and Italy are both in the market and considerable has been sold to domestic consumers at $16.50 to $18 per unit, depending on the quality, quantity, and delivery. Demand for ferro-tungsten is good with the quotation at about $2 per lb. of contained tungsten.

Company Reports

AMERICAN SMELTING & REFINING CO.

The eighteenth annual report announces earnings for the year 1916, after deducting general expenses, fixed charges, and corporate taxes, of the handsome sum of $25,242,297. The increase in net receipts amounts $8,999,877 over those for 1915, and to $14,430,382 over earnings made in 1914. A depreciation charge, including depletion of ore-reserves, of $1,990,047, was deducted from the net earnings, in addition to $575,000 distributed as employees' bonuses, $275,000 appropriated for pension-fund, and $150,000 for welfare-work. After meeting obligations on account of preferred stock, there was left applicable for dividends $16,158,991, being in excess of 30% on the outstanding shares, in addition to the regular quarterly dividends at the rate of 6% per annum. A sum of $6,000,000 was carried forward in the reserve fund for enlargement and extension. The prevalent high prices have stimulated production of ore and bullion, and the smelting and refining operations of the company have correspondingly increased. At the same time the cost of fuel, miscellaneous supplies, and the wages paid to labor, have advanced to such a degree as to make the management of the complex operations of the company most difficult. Some departments of this group of related industries have been unprofitable, but there have been compensating gains in other departments. The policy of the company is declared to be one of expansion, so that a large proportion of the abnormally high net earnings will be devoted to preparations for more diversified production in the future, so as to insure a continuance of earnings which could not otherwise be expected. None of the Mexican smelting plants of the company were operated during the year 1916, but a few of the mines were worked, entirely under Mexican supervision. In efforts recently made to resume normal operation at the Monterrey and Matehuala plants it has been found necessary to move all materials with the aid of locomotives and cars belonging to the company. The Board of Directors, however, expresses the opinion that "all business in Mexico must expect to be greatly hampered by high costs, especially in taxation and freight." In Chile a policy of general expansion has been decided upon, and the company has purchased the Caldera smelters, "together with a highly mineralized zone, including many mines, which are but imperfectly developed. There has been purchased also the stock of the Carrizal Smelting Co. An important and favorably developed mining property in Mexico adjoining the mines of the company at Parral was secured at a value which was believed warranted, even if operations may be considerably delayed."

More than $5,000,000 was expended in betterment of the copper-smelting and refining plants, owing to the increasing demand for electrolytic copper. By the middle of this year the company will have a capacity for producing 1,300,000,000 lb. of electrolytic copper per annum. The large decrease in supplies of lead ore formerly derived from the Coeur d'Alene mines has led to the expenditure of about $750,000 in the development of the company's properties in Missouri. A sulphuric acid plant, with a capacity of 50,000 tons per annum, has been completed at Salt Lake, and this will be duplicated as soon as a market for the acid can be found. An appropriation has been made for a research laboratory having in view the development of chemical industries in which larger quantities of sulphuric acid may be utilized. Closer attention is also being given to the saving of the minor metals and valuable non-metallic substances present in the ores treated at the company's works. The magnitude of a great smelting industry is illustrated by the cash receipts during the year of $358,117,836, and from the striking comment in the report regarding metal-stocks, as follows: "At no point in the accounts submitted is the enormous increase in business being done at the ending of the year, as compared with the beginning of the year, so vividly portrayed as in the inventory-value of metal-stocks. The book-value of ore, bullion, and factory-products on hand and in transit on December 31, 1916, less treatment-charges accrued but not earned, was $105,254,064.81 as compared with the value of the same stock at the end of the preceding year, $58,582,142.69, or an increase of $46,671,922.12. This increase is very largely in the weight of metal carried in the normal business of the company, as the average inventory-price at which metals are carried has not been increased during the year. Of this enormous increase, however, $42,813,133.96 is for account of mining companies. The increase in inventory value of metals held at the risk of the company during the year is $3,858,788.16, which is only the normal increase made necessary by the total increase of material delivered to the smelting and refining works, together with the added carry, on account of delays in transit from smelters to refineries, due to the congestion of traffic, with which the whole country is acquainted.

ISLE ROYALE COPPER CO.

The directors of the Isle Royale Copper Co. submit the following report of the operations of this company for the year ended December 31, 1916:

Gross value of fine copper produced:		
12,412,111 lb.	$3,209,537.18	
Silver sales	53,086.76	
		$3,262,623.94
Running expenses at mine	$1,412,032.58	
Re-opening No. 1 shaft	7,510.84	
No. 7 shaft	49,696.95	
Unwatering Huron mine	5,183.62	
Exploration	479.15	
Smelting, freight, commission, Eastern office, etc.	384,784.61	
Balance of interest	6,281.18	
		1,865,968.93
Profit for year 1916		$1,396,655.01
Accounted for as follows:		
Increase in capital assets, viz.:		
Construction		$88,529.12
Increase in investments in other companies, viz.:		
Lake Milling, Smelting & Refining Co. stock		16,098.59
Increase in working capital, viz.:		
Increase in current assets and deferred charges	$464,149.76	
Decrease in current liabilities	77,877.54	
		542,027.30
Dividends declared in 1916		750,000.00

PHELPS, DODGE & CO.

Earnings of Phelps, Dodge & Co. for the year 1916 amounted to $24,030,905, an increase of 140% over the previous year. On the stock there was earned last year 53.4%, against 24.4% in 1915 and 14.8% in 1914.

The income account compares as follows:

	1916	1915	1914	1913
Net earnings	$24,030,905	$10,981,512	$6,664,839	$9,407,710
Dividends	14,625,000	9,000,000	6,300,000	7,425,000
Ore depl. and plant dep.	2,056,642	1,261,037	.....	*1,500,000
Surplus	7,349,263	720,475	364,839	482,710
Previous surplus	8,337,864	7,617,389	6,646,270	6,163,560
Total surplus.	15,687,127	8,337,864	7,011,109	6,646,270

*Depreciation in value of stocks owned.

At the end of 1916 Phelps, Dodge & Co. had current assets of $24,482,131 of which $7,746,520 was cash, $3,062,032 market-

able securities, $4,031,300 accounts receivable and $7,993,924 representing metals in process of treatment and on hand. The balance of $1,648,355 was merchandise held for sale. Current liabilities totaled $5,826,777 of which the largest item was $3,830,597 representing accounts payable. President James Douglas says: "Production of copper for the past year has greatly exceeded any in the company's history. The metal produced from the ores of the constituent companies of Phelps, Dodge & Co., Inc., was 152,263,729 pounds of copper, 10,404,341 pounds of lead, 1,642,055 ounces of silver and 28,873 ounces of gold; and in addition there was purchased or smelted on toll at the reduction works of the company ores yielding 37,823,828 pounds of copper, 588,327 ounces of silver, and 7802 ounces of gold. Including copper received from other sources, 247,303,587 pounds were sold and delivered to buyers at an average price of 24.48 cents per pound net cash f.o.b., New York:

	Pounds
To domestic trade	176,468,527
To foreign trade	70,835,060
Total deliveries	247,303,587
Phelps, Dodge & Co. sold	
Of their own mine product	138,968,320
Of copper from ores purchased	34,742,080
Of copper on commission	73,593,187

"The stimulation of high prices, together with the satisfactory settlement of the labor difficulties in Morenci, improved political conditions in Sonora, and the inception of production at the Burro Mountain property, served to increase over 1915 output of copper 25,492,039 lb. and a total of 48,957,135 lb. from the reduction plants, which includes ores purchased or smelted on tolls."

CALUMET & ARIZONA

The Calumet & Arizona Mining Co. reports for 1916 net earnings of $17.36 per share, from which dividends of $9 were paid. The income account and production figures compare as follows:

	Received for copper, gold, and silver	Operating expenses	Net income
1916	$20,495,430	$11,156,835	$11,155,005
1915	11,647,415	6,225,595	5,453,881
1914	8,518,999	5,303,375	3,085,535
1913	9,181,995	4,960,528	4,074,637
1912	9,131,967	4,547,973	4,550,883

Operating statistics:

	Copper, lb.	Cost copper per lb., c.	Silver, oz.	Gold, oz.
1916	74,898,788	9.04	1,863,149	43,378
1915	65,268,910	*	1,381,078	35,264
1914	52,667,929	8.19	922,143	24,122
1913	56,987,383	7.65	880,915	19,989
1912	53,108,628	7.02	594,319	22,881

*Not reported.

Underground development work during the year aggregated 125,282 ft. as compared with 93,789 ft. in 1915.

Under the sliding scale of wages the miners received a maximum of $5.85 per day in December as against $3.60 per day in 1914.

BRUNSWICK CONSOLIDATED MINING CO.

The annual report of the Brunswick Consolidated Gold Mining Co. of Grass Valley, California, shows a total production of the mine from 1893 to December 31, 1916, of $1,582,846.90. Nine dividends have been declared, aggregating 51 cents per share. There have been levied also 42 assessments, amounting to a total of $1.22 per share. During the year 1916 a total of 34,091 tons of ore was crushed, producing $196,520.99; of which $166,573.51 was in bullion and $29,947.48 was from concentrate. The average assay-value of the ore was $6.435 and that of the tailing $0.671. The average extraction of value was 89.5%. Costs were distributed as follows:

General expense	$0.5896
Mining	3.8745
Milling	0.8304
New shaft	0.2491
Repairs	0.1530
Improvements	0.2011
Total	$5.8977

OSCEOLA CONSOLIDATED MINING CO.

The Osceola Con. Mining Co. of Michigan reports for the year ended December 31, 1916, as follows:

Gross value of fine copper produced		$5,040,012.69
Interest		25,121.32
		$5,065,134.01
Running expenses at the mine	$1,744,884.22	
New construction	66,057.90	
Smelting, freight, commissions, etc.	478,032.34	
		2,288,974.46
Net profit		2,776,159.55
Dividends (4) during the year		1,826,850.00
Increase in current assets		$ 949,309.55
Balance of assets December 31, 1915		2,166,646.51
Less not included in current assets:		
Wood and timber lands	$ 37,309.18	
Mineral Range railroad stock	341,100.00	
Lake Superior Smelting Co. stock	60,000.00	
		438,409.18
Balance of current assets December 31, 1915		1,728,237.33
Balance of current assets December 31, 1916		$2,677,546.88

SILVER KING CONSOLIDATED MINING CO

The Silver King Consolidated Mining Co. of Utah reports for the year ended January 31, 1917, as follows:

RECEIPTS

Balance February 1, 1916	$232,644.72
Ore sales	500,498.52
Miscellaneous income	175,746.71
Total	$908,949.95

DISBURSEMENTS

General expense	36,107.00
Mining	110,432.25
Other expenses	47,571.06
Surface improvements	102,035.64
Dividends	294,561.56
Miscellaneous	318,242.44
Total	$908,949.95

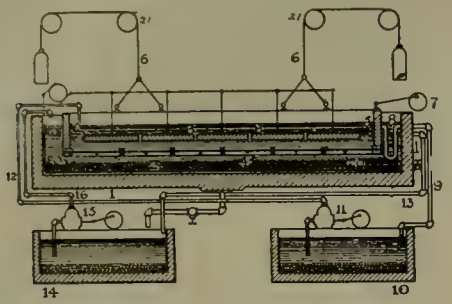
YUKON GOLD

The Yukon Gold Co. reports for the year ended December 31 last as follows:

Received from gold operations	$4,383,595
Operating expenses	2,291,235
Operating income	$2,092,359
Other income	9,342
Total income	$2,101,701
Charges	994,191
Balance	$1,107,510

Recent Patents

1,209,835. Process of Treating Materials Electrolytically. William E. Greenwalt, Denver, Colo. Filed May 13, 1913. Serial No. 767,392.

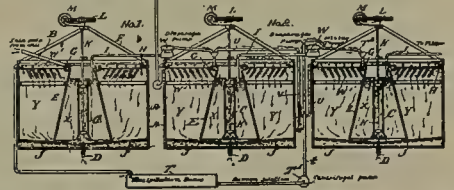


1. An electrolytic process which consists in maintaining separate the anolyte and catholyte with a suitable diaphragm, simultaneously agitating both the anolyte and catholyte and withdrawing the electrolyte from one compartment and passing it through the other compartment without mingling with the electrolyte of the other compartment.

1,209,934. Concentrating-Table. Emil Deister, Fort Wayne, Ind., assignor to Deister Machine Company, Fort Wayne, Ind., a Corporation of Indiana. Filed June 15, 1916. Serial No. 103,809.

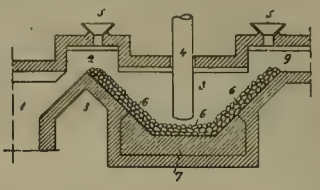
1. A transversely inclined concentrating-table having a deck, means for vibrating the deck, riffles arranged on the deck substantially parallel with the direction of vibration, means for feeding the material onto the head of the table, said table being downwardly inclined from the head to the tailings discharge edge, but substantially level in the direction of vibration, the riffles having their upper surfaces in a plane substantially parallel with the main surface of the deck for substantially their entire length, in combination with a plateau, substantially parallel with the main surface of the table and arranged along the mineral discharge edge, and an inclined surface arranged diagonally across the deck for causing the valves to move up above the surface of the material overlying the main surface of the deck and onto the plateau.

1,211,828. Apparatus for Thickening and Agitating Pulp. John Van Nostrand Dorr, Denver, Colo. Original application filed Sept. 9, 1912. Serial No. 719,465. Divided and this application filed June 26, 1913. Serial No. 775,884.



Apparatus for thickening and agitating pulp, comprising a series of vessels each provided with a separator having on one side a chamber in which the pulp is agitated and on the other a space for quiet settling, means in said chamber for thoroughly agitating the thickened pulp, means connecting the agitating chamber of one vessel with the settling space of another, and means for conducting the clear liquid from one vessel to and mixing it with the thickened agitated pulp passing from the agitating chamber of another vessel in the series before said agitated pulp descends to another settling area.

1,207,127. Method of and Apparatus for Obtaining Zinc. Edward S. Berglund, Trollhättan, Sweden, assignor to Trollhättans Elektrothermiska Aktiebolag, Trollhättan, Sweden. Filed Sept. 15, 1914. Serial No. 861,758.



1. In extracting zinc in an electric furnace the method of reducing and purifying the metallic vapors developed in the furnace, consisting in passing said vapors after leaving the furnace and on their way to the condenser, over a layer of reducing material, without passing them through such material and heating them above the condensing temperature.

1,210,017. Electrolytic Recovery of Zinc from Ores and Other Zinc-Bearing Materials. Urlyn Clifton Tainton, Johannesburg, Transvaal, South Africa. Filed Aug. 10, 1915. Serial No. 44,837.

1. A continuous electrolytic process for the extraction of zinc from zinc-bearing material which consists in forming therefrom a concentrated solution of a zinc-salt containing an excess of acid, electrolyzing the solution with a current of high density, regenerating the said solution by dividing it into two portions in such proportions that, when the acid in one portion is neutralized by the addition to it of a charge of zinc-bearing material and the resulting solution separated from the residue and mixed with the other portion of the electrolyzed solution which has been retained, the acid-content of the final solution shall be approximately the same as that of the original solution and then electrolyzing the regenerated solution with a current of high density.

1,205,944. Process for Sintering Fine Ores, Flue-Dust, Purple Ore and the Like. Carl Giesecke, Bad Harzburg, Germany. Filed Aug. 30, 1916. Serial No. 117,735.

1. The herein-described process of sintering finely-divided material containing iron, which consists in mixing such material with slimes; agglomerating the mixture; and heating the agglomerate, together with finely-divided fuel, in a shaft furnace.

2. The herein-described process of sintering finely-divided material containing iron, which consists in mixing such material with slimes containing a high percentage of clay; agglomerating the mixture; and heating the agglomerate, together with finely-divided fuel, in a shaft furnace.

1,207,243. Process for the Recovery of Metals from Ores and the Like. Charles S. Vadner, Butte, Mont. Filed May 23, 1916. Serial No. 99,465.

1. In the art of recovering copper and other metals from mineral matter and the like consisting in treating the naturally oxidized or sufficiently roasted sulfid ore with sulfurous gases and the like in the presence of heat and a solution containing at least one of the common chlorids that can react, for the purpose of effecting the desired reactions, leaching out the metals from the mineral matter eliminating excess acidity of solution, passing air through same thereby precipitating iron as ferric oxid, eliminating same, further eliminating excess acidity of solution and sufficiently heating same whereby copper is precipitated as cuprous chlorid.

Mining Decisions

Oil Lease—Nature of Lessee's Title

An ordinary oil lease vests no title in the lessee to the real estate, but only the right to explore for and extract the oil.

Kelly *v.* Harris (Oklahoma), 162 Pacific, 219. January 23, 1917.

Mining Royalties—Classified as Land Rents

Royalties from a mine were held to be "rents and profits from lands" in construing a trust.

In re Petit's Estate (Minnesota) 161 Northwestern, 158. January 26, 1917.

State Lands—Lease of Mineral Rights

Under a statute providing for leases of unencumbered mineral lands, the State cannot make a lease of mineral rights on oil lands which have been previously sold under contract with a reservation to the State minerals, unless provision is first made to compensate the surface purchaser for damages from drilling operations.

State *v.* Savidge (Washington), 161 Pacific, 471. December 12, 1916.

Mining Contract—Suit for Royalties

The parties defendant entered into an agreement to buy a mine for a certain price in cash, balance to be paid in royalties. The cash price was paid and the deed delivered but the defendants never commenced mining, nor was there any specific provision in the agreement that they must commence work within a given time or at all. Held, on a suit for recovery of the balance of the purchase price that the defendants were not required to pay it unless they elected to commence mining operations.

Johnson *v.* Geddes (Utah), 161 Pacific, 910. December 28, 1916.

Patent Proceedings—Theoretical Exclusions

Where exclusions are made from the application for patent of mining claims of supposed conflicts with a prior patented claim, and the position of the prior patented claim as actually marked, defined and established upon the ground is not identical with its position as represented upon the plat and described in the field notes of survey, and the supposed conflicts have no existence in fact, the areas represented by such theoretical exclusions pass under the patents to the claims and are therefore not subject to appropriation by subsequent location.

Wasatch Mines Company (Land Department), 45 Land Decisions, 10. March 15, 1916.

Railroad Patent—Mineral Character—Burden of Proof

The return of the Surveyor-General as to the character of land in an application for patent of a railroad listing constitutes a small element of construction where the question as to the character of the land is at issue. Where the question of mineral or non-mineral character is put in issue by the report of a special agent, the burden is upon the railroad company to show by clear and convincing evidence that the land is non-mineral. It is not incumbent upon the government to show a discovery of mineral such as would serve as a basis for mineral patent. It is sufficient to justify denial of the railroad patent if the land be shown to have a prima facie mineral character and a prospective value for minerals greater than any other known value.

Central Pacific Railway (Land Department), 45 Land Decisions, 25. April 7, 1916.

Recent Publications

The Mineral Resources of Oregon. Vol. 2, No. 4. A handbook of the mining industry of the State, with a description of mining districts. By H. M. Parks, State Geologist, and A. M. Swartley. Pp. 306. Maps, Ill. Oregon Bureau of Mines, Corvallis, 1916. This work, the latest of the monthly publications of the Oregon State Bureau of Mines, is a valuable and timely compilation of the mines, quarries, and mineral-producing industries of that State, alphabetically arranged. Many of the more important mines are carefully described, and the descriptive text of some of them is illustrated by line drawings, maps, and half-tones. The geology of the principal mining districts is also gone into, and on the whole the book will be found an acceptable addition to scientific mining and geological literature of Oregon.

Report of the Royal Ontario Nickel Comission. Pp. 528. Ill. and maps. Toronto, 1917.

This valuable volume contains the findings of the Commission appointed by the legislative assembly of Ontario, to investigate thoroughly the nickel industry of Canada, including mining and reduction of the ores and refining of the metal. The Commission visited the nickel mines of the world, and investigated the nickel industry from every point of view, and their findings are of value to all interested, not only in the production of nickel, but in every industry wherein nickel is used in any form. The two questions given the greatest weight during the investigation were, can nickel be economically refined in Canada? and are the nickel deposits of Ontario of such a character that the Province can complete successfully as a nickel producer with any other country?

West Virginia Geological Survey, Morgantown, W. Va., comprising the detailed geology of Jefferson, Berkeley, and Morgan counties. By G. P. Grimsley, pp. 644 + XXVI. Ill., with maps. Price, with case of maps (delivered), $2.50. Extra copies of map, $1.

The Production of Cement, Lime, Clay-Products, Stone and Other Structural Materials in Canada in 1915. Department of Mines, Ottawa, 1916.

The Production of Copper, Gold, Lead, Nickel, Silver, Zinc, and Other Minerals in Canada in 1915. Department of Mines of Canada, Ottawa, 1916.

Commercial Paragraphs

The Lunkenheimer Co., of Cincinnati, Ohio, states that during the past year, there was a great demand for valves made entirely of iron for use in handling cyanide and other solutions which attack metals having copper as their basic element, and which consequently could not be handled by brass-valves or valves having any part made of brass. This company supplied a large number for use in dye and chemical manufacturing plants, but the demand was not confined to these sources, as quite a number were also supplied for use in mines, oil-refineries, tanneries, pulp and chemical fiber-mills, canning and packing-establishments.

Bricks recovered from the walls of old buildings have for years been cleaned by men who laboriously chipped off the tightly adhering mortar. This method has been superseded by the air-hammer, which quickly removes the mortar and renders the brick as good as new. Old paving-bricks also can be renovated in the same manner. The work is generally accomplished by means of a small portable compressor, such as the Sullivan 15-hp. class WK-3, a portable single-stage machine, operated by a gas-engine, as described in *Mine and Quarry* for March. The hammer used is the Sullivan DA-15, 25-lb. plug-drill, and a Sullivan DB-13 hand-pushing machine, equipped with bits like those on a cold-chisel.

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Edited by T. A. RICKARD

Volume 114
Number 16

SAN FRANCISCO, APRIL 21, 1917

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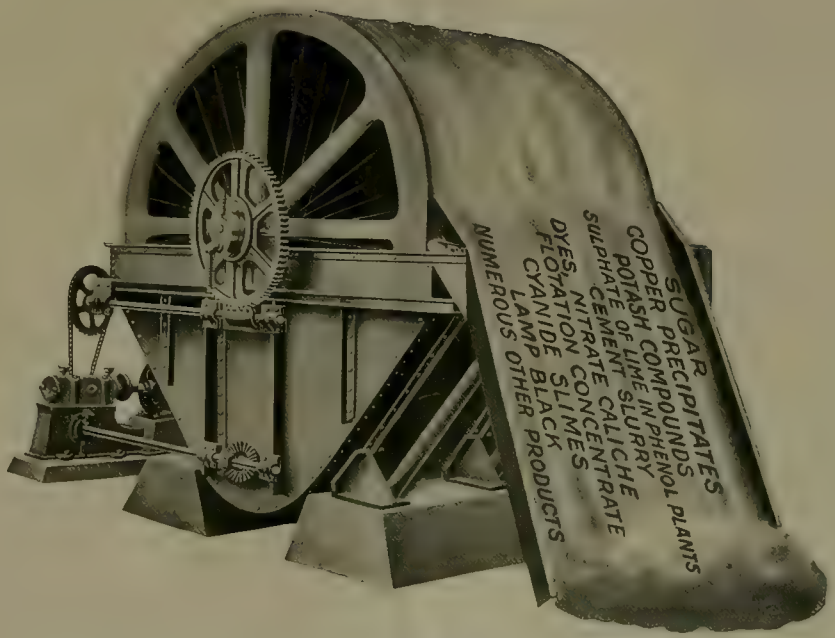
In This Issue:

Methods of Mining Big Orebodies
Characteristics of Magmatic Sulphide Ores

The Oliver Defines Economy



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Science has no enemy save the ignorant

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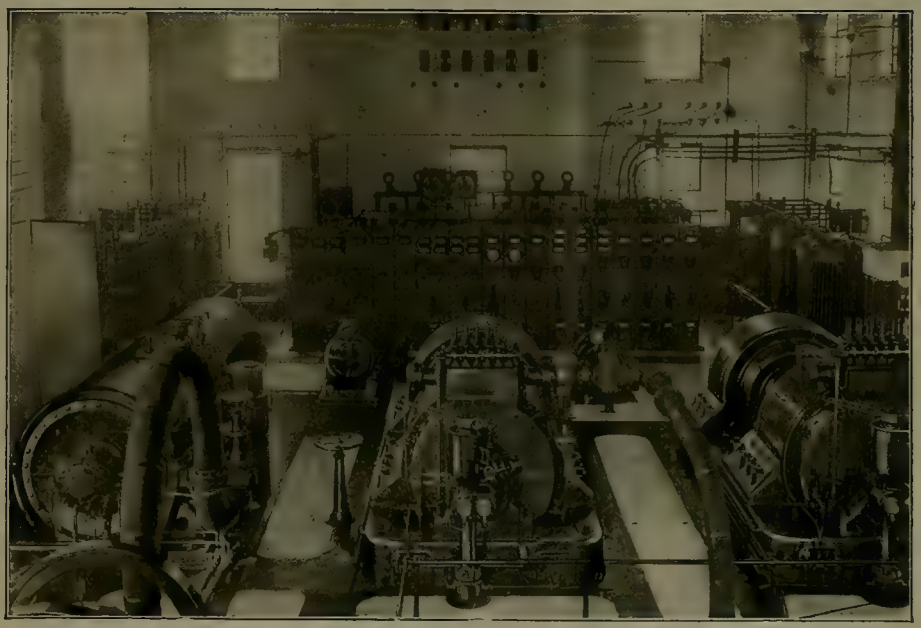

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EDITORIAL

T. A. RICKARD, Editor

SPEAKING of patriotism, we confess to admiration of *The Spectator*, that lineal descendant of the paper founded by Addison and Steele, for its present proprietor, being called upon by the new regulations of the British government to decrease the number of pages in his periodical and so save freightage on paper-pulp, cut out his advertising pages.

THE PRESIDENT has called upon every citizen to co-operate in the national effort to wage an effective war "for democracy and human rights." He appeals, among other elements in the population, to the miner in these words: "To the miner let me say that he stands where the farmer does. The work of the world waits on him. If he slackens or fails, armies and statesmen are helpless. He also is enlisted in the great service army." What he says about extravagance, personal and industrial, should be noted in every mine, mill, and smelter: "This is the time for America to correct her unpardonable fault of wastefulness and extravagance. Let every man and every woman assume the duty of careful provident use and expenditure as a public duty, as a dictate of patriotism which no one can now expect ever to be excused or forgiven for ignoring."

ON another page we give information concerning the enlistment of men for the Engineer Reserve Corps of the Army, so that those willing to serve may know to whom to apply and under which branch of this particular service to enroll themselves. As soon as they are needed they will be called into active service. Undoubtedly a large proportion of the personnel engaged in mining, from trammer to manager, can find suitable and congenial employment in the Engineer Corps and we recommend it to them as being preferable to enlistment in the line. Without unduly depreciating the patriotic sentiment expressed by the organization of home guards, troops for State defence, and the like, we venture to lay stress on the need for meeting this crisis in a truly national spirit rather than as citizens of any political or municipal sub-division of our country. This War can be brought to a successful issue only by a loyal and co-ordinated effort on the part of all its citizens without distinction of town or State.

MISUNDERSTANDING exists as to the ownership of the Cottrell patents. Mr. F. G. Cottrell assigned the right to administer his patents for all smoke-work throughout the United States, except in Arizona, California, Oregon, and Washington, to the Research Corporation, acting in behalf of the Smithsonian Institution. The right of application to industrial smokes in the four States excepted is held by the Western Precipitation Company, which also retains the right to apply these patents to the cement industry throughout this country. This company likewise controls the foreign patents to the Cottrell inventions, and recently sold its rights in Japan for a handsome sum to a syndicate composed of four well-known Japanese smelting companies. To this we may add the news that the Anaconda Copper Mining Company has decided to proceed with the erection of a big Cottrell equipment, the first being designed to treat 3,000,000 cubic feet of gas, this plant to consist of 20 units, each capable of treating 150,000 cubic feet per minute at a velocity of six feet per second. In the newer plants the detaching of the sublimate from the tubes is effected by a lever, so as to obviate the crude method of employing a man to hammer the tubes in order to collect this product. Noise and smoke usually indicate rudimentary or incomplete metallurgical processes.

CRITERIA for distinguishing, by a study of the ore-minerals in a deposit, the conditions under which deposition occurred are of the highest practical value to engineers entrusted with the responsibility for developing mines. Astute recognition of the criteria means correct inferences as to probable structural habit of the orebody and its relationship to the associated rocks. Rightly or wrongly, all men, from the prospector to the trained economic geologist, judge the ores they meet in their work and draw conclusions from what they see as to the place and character of the ore unseen. Such a contribution to the interpretation of genetic evidence as that contained in the paper by Messrs. C. F. Tolman, Jr. and Austin F. Rogers, published on another page of this issue, will be eagerly received. It throws new light upon magmatic segregations of sulphide minerals, and adduces proof that such concentrations represent a closing phase of the consolidation of the magma, and even follow the solidification of the quartz, but that they are not to be confounded with hydro-thermal deposits, which may be formed either at a still later stage, or entirely beyond the limits of the rock from which the mineralizing agents proceeded. Opportunity to observe the peculiarities presented by ores of the character under discussion coming from exceptionally deep Californian mines adds further significance to the discriminations that these investigations offer as a guide to geologists.

AMONG the curiosities of promoting 'literature,' we may mention the prospectus of the Arizona-Tonopah Mining &c. company as published in a pamphlet entitled 'Facts.' Among sundry glittering statements concerning the dividends paid by famous mines the reader is

assaulted by an electric sign telling him to "Watch Arizona-Tonopah go to a dollar per share" and similar electrifying assertions. We are told that whereas railroads return 3% on the capital invested in them and National Banks 6¼, it is a 'fact' that mining pays 182% on the capital invested. This cheerful lie is said to be based on "some Government data." *Some* data! Among other romantic yarns, we are told that a "railroad engineer now living in Pueblo, Colorado, let a friend talk him out of buying $300 worth of Mollie Gibson at 1¼ cents per share. This same man saw Molly Gibson stock advance to $15 per share in less than a year, and today grieves over the fact that he let a friend talk him out of $372,000 which his own conscience told him to buy." No wonder his conscience was grieved—also his pineal gland. But how about the thousands of men that bought other stock at $1.50 on the same kind of tip and saw it go to 1½ cents per share? Ask George Graham Rice and the gentlemen that play the 'game' of peddling wild-cat stocks. Instead of reports by well-known engineers the possible speculator is given the story of the cabalistic signs deciphered by "the most eminent entomologists." The signs on the rocks were examined by these 'entomologists'—a good word, having something to do with bugs, in the head or elsewhere—and they pronounced the meaning of the inscriptions to be 'Great Mines' or 'Rich Mines.' That, of course, settles it—what could be better than this laconic report written 000 years ago. The cabalistic signs pointed in the direction of "the veins or leads of ore." Thereupon, of course, the original discoverer, who is also the general manager and treasurer—especially treasurer—of the company proceeded to uncover the Aztec treasure-house in which, dear reader, you and we are given the opportunity to acquire such wealth as will give us greater ease and dignity without unnecessary fuss.

EVEN clever people make simple mistakes. We have been surprised repeatedly to find how many of the Japanese gentlemen that come to this country on a mining and metallurgical tour are unable to speak English with any comfort or success. It would appear to us, judging from our own experience, that a round of visits of observation to mines, mills, or smelters might be ineffective as a means of collecting accurate information so long as the visitor is unable either to ask precise questions or to understand specific replies in the language of the country. The chances for misunderstanding must be enormous and we can quite imagine that some of the younger Japanese engineers return home with a weird assortment of undigested data. We mention the matter in the interest of all concerned, not only the visitors but the managers of mines and smelters to whom the lack of an effective medium of speech is an insuperable block to the giving of mental hospitality. We are fully aware that this criticism in its rebound strikes a national weakness of our own. Probably not one American out of ten thousand that has visited Japan went equipped with a dozen words of Nipponese. Our conceptions of the Mikado's empire, its ideals, and its purposes are consequently a mixture of conjecture, sentiment, and official misinformation. We have but little more to our credit as regards comprehension of the institutions and the peoples of Latin America. Our merchants have sent hordes of commercial travelers into South America and they have developed no important trade; our periodicals have repeatedly commissioned correspondents to reveal to us our southern neighbors, and they have either maligned them or treated them as a joke, at the same time filling columns with meaningless statistics of trade opportunity abstracted from the files in the Bureau of the American Republics at Washington. Although there exists a large body of American mining engineers who possess a moderate command of the Spanish language, the majority of mining enterprises in the countries to the south have suffered through the inability of those in charge to use the current medium of communication. A great part of the general imputation of inefficiency on the part of Latin-American labor, and of corruption on the part of the officials, has its origin in failure to understand; the man who is not alert to the thought of those around him offers temptation to profit at his expense.

CARRANZA has donned a garment of neutrality, but it was clearly not cut to measure. It is a cheap 'hand-me-down,' which fails to cover the naked truth of his international policy. Little more than a month ago he was posing as a pacifist, declaiming against the barbarisms of war and proposing by a circular letter to all the republics of America that they refrain from the exportation of munitions and supplies to Europe. This is the kind of neutrality that is meant to neutralize the efforts of one belligerent for the advantage of the other. The inspiration for this species of fraternal affection is not difficult to trace. Meanwhile evidence has accumulated showing that he has allowed Mexican ports to be used as a base for German submarines, and that more recently he has connived at the use of a Mexican railroad with shops and terminal facilities in promoting a submarine campaign in the Pacific aimed primarily against the shipping of this country. This is in striking contrast with his obstinate refusal to permit the American troops to use the railroads in Chihuahua when sent in pursuit of Villa, who was then assumed to be the common enemy of the United States and of the so-called *de facto* government. At the same time it is noteworthy that by nationalizing the oil-fields, subjecting them to bureaucratic control under the provisions of the mining law, he is preparing to take advantage of any technical opening that could be found for harassing American and British interests. The old adage, "He that is not with us is against us," would seem to apply with peculiar force to our 'neutral' neighbor. No one can mistake the hostile purpose conveyed in the cryptic response of Carranza to the diplomatic representatives of this government, expressing regret that the United States should have been unable to solve its difficulties

with Germany in a peaceful manner, and assuring us that Mexico would omit no effort to contribute to the bringing about of peace. It assists to an understanding of this mellifluous phrase to recall the sanguinary significance of 'pacification' as used in Hispanic military decrees. Concurrently with other disquieting news come reports of more than five thousand Mexicans quitting work in southern California within the last two weeks and withdrawn to their own country, from which most of them had fled as political refugees or to avoid military service with the revolutionary factions. Coupled with persistent reports of the pernicious activity of German agents in Mexico City, the address by Carranza at the opening of congress, wherein he sets forth his grievances at labored length, intensifies the prevalent distrust of his motives. He accuses the United States of official misrepresentations, and sullenly characterizes the late punitive expedition as war upon Mexico. These are not words of peace coming from the man who owes his present position to the active support of this Government. A cordial understanding between the United States and Mexico at this time would instantly lead to the rehabilitation of Mexican industry and finance and would strengthen the hands of the existing government. It must be assumed that the acts of Carranza are dictated by his vision of selfish interest.

Business Not As Usual

Several of our Eastern contemporaries, not fully realizing the extent of the industrial re-organization that military preparation must involve, have made what we venture to call the serious mistake, on the morning of the declaration of war against Germany, of going out of their way to recommend 'Business as Usual,' in the course of which they re-iterate the slogan adopted by the British at the beginning of hostilities. The advice to keep cool, not to slacken routine effort, to throw fresh energy into constructive work, to expand business with a view to "giving strength to the man who actually fights," and so forth, is well enough in its way, but it is only too likely to be converted into selfish detachment and crass self-interest. The Great War has given us three infamous or pitiable sayings—each reader may select his own adjective, gently or strongly opprobrious, as he sees fit—those three are "a scrap of paper," "business as usual," and "too proud to fight." Two of them have gone to the scrap-heap; the first has yet to be driven down the throat of him who uttered it. "Business as usual" is not for us to echo. When the guns of Liége could almost be heard in England, the business was considered so usual that young men played cricket and older men played golf as if nothing had happened. They have learned since then how their unpreparedness has cost the lives of thousands of brave men and prolonged the War by months and years. They have atoned honorably and gloriously for their early mistake; we shall have no excuse for committing a like blunder, for their example is too recent. Let us imitate not the blunder but the splendid rectification of it. The business in which we are engaged is most unusual and we should realize it every moment of our day. All that we do should have a newer meaning and a deeper purpose—to serve our country, to work for a great cause, to do our share in promoting the only result that will make the world a fit place where free men may live and pursue happiness in an orderly way.

Mining Law Revision

Revision of the mining law will be taken up at the long session of Congress in December. This news comes from Washington upon the authority of Dr. Martin D. Foster, chairman of the committee on mines and mining. Dr. Foster has expressed distaste for the inactivity that has been forced upon his committee in the past. He complains that demands for revision were made, and that as soon as the committee showed signs of taking seriously such requests from men interested in mines, insistent demands for delay came from other equally important groups. He also made the remark, not without a smile, that while no constructive aid broadly representative of American mining was offered the congressional committee in framing a bill, lively interest in the movement for new legslation was taken as soon as a proposal was submitted for a junketing expedition to visit the leading mining centres of the West at Uncle Sam's expense, ostensibly for the collecting of evidence as to the specific needs of mine-owners and operators, and the difficulties to be overcome by a new statute. We have criticized the Foster bill, which was drawn up solely to stimulate discussion. The committee and its chairman desire to make progress toward revision, and they have earnestly invited those whose business gives them an understanding of the needs of the miners to submit one or more bills for consideration, based upon which a workable mining law may be framed. They appear, however, to underestimate the value of the suggestions, going so far as the drafting of new regulations, proposed by the committee of the Mining and Metallurgical Society and they overlook the work done by numerous committees, one of the more important being that selected by the American Institute. Apparently there is a lamentable failure to co-operate between the mining societies and the gentlemen in Congress. They do not appear to have such sympathy and respect for each other's efforts as is necessary to effective legislation. Dr. Foster himself acknowledges that he knows nothing about mining; he is a physician by profession; he claims, however, to have an open mind and to be willing to listen to good advice. As we have suggested more than once, any radical change in the mining law will be dangerous unless it comes as the logical consequence of a thorough revision of the entire system of land laws, after these have been studied carefully by a commission specially qualified to pass judgment. We are glad to state that Senator Smoot has seen the error of his ways and abandoned his scheme of piece-meal revision; he has now in-

troduced a bill providing for a commission of three experts, giving them a year to study the mining laws of various countries before formulating suggestions for a new code. The present law is faulty in many ways, but the intent of it has been clarified by a long series of court decisions so that the miner knows fairly well just where he stands in relation to the Government and his fellow citizens. To repeal the 'law of the apex' without a thorough revision of the other regulations will land the mining community in a new maze of lawsuits and leave us worse confounded than before. Dr. Foster and his committee had better not 'monkey with a buzz-saw' until they know more about the mechanics of the thing. The duty of those who are interested in the industry is manifest. The campaign for new legislation will end in a joke or a disaster unless the men who have the matter at heart lay aside questions of pique and precedence, and work in harmony.

Deeper Mining at Treadwell

Our readers will be interested to learn that plans for the deeper development of the Treadwell group of mines are being put into effect. This is in accordance with the recommendations of the president of the three consolidated companies, Mr. F. W. Bradley, as embodied in his report of October 20, 1916. A constructive programme was summarized in that report, including the equipment of the Combination shaft, first with a man-hoist and then with an ore-hoist. In 1916 the Alaska Treadwell earned $432,670 and the Mexican $5760, while the United made a loss of $129,530, this last being due to the unusual proportion of underground work in the 700 claim and the new shaft on the Ready Bullion. The diamond-drilling of the deeper ground was completed recently, the first 345 feet of the last bore, which started from the 2300-ft. level, cutting through ore averaging $2.42. The diamond-drilling campaign has developed 3,887,000 tons of $2.25 ore between the 2300 and the 2700-ft. levels. A similar stretch of ground in the upper levels would have shown 5,600,000 tons of $2.63 ore. However, the progressive improvement in the deeper workings since the poor zone was entered at 1750 feet is shown by the sampling and drilling, the averages being:

1750-ft. level	$1.46
1950 " "	0.65
2100 " "	1.65
2300 " "	2.06
2500 " "	2.21
2700 " "	2.44

The economic limit is an assay-value of $2 per ton, from which 90% is extractable. What may be the cause for the higher gold-content on the deepest levels is not known. The wall-rocks are the same. The orebodies consist of the gold-bearing portions of an albite-diorite dike. A flattening of the dip below 1600 feet and a straightening of it at about 2100 feet is associated with changes in the grade of the ore. The shortening of the ore-bearing ground in depth is due to the position of the Star dike, which is pushing into the ore-bearing dike. The mine has had its vicissitudes. The ore exposed at the surface was profitable down to 450 feet, while another and northern orebody was poor at the surface, becoming workable at a depth of 350 feet. This northern orebody was stoped down to 750 feet, where it became poor, continuing so for 325 feet (to 1075 feet) and then became rich enough to stope from this point down to just below the 1400-ft. level. From there it has been unproductive in the Treadwell mine. Meanwhile the south, or main, orebody was poor from 450 feet to just above the 600-ft. level; from there to a point mid-way between the 1600 and 1750-ft. levels this orebody was highly productive. Below this point neither orebody was any good until about 2100 feet from the surface was reached. The poor zones in the higher levels, notably at 750 feet, were not emphasized by any diminution of output because new ore-ground was opened up so rapidly, and sufficiently in advance of mill requirements, that there was no trouble in maintaining the regular production. It requires from five to seven years to open and draw the ore between two levels. In passing we may note that much of the so-called quartz associated with the gold in the Treadwell dike is a feldspar, albite. Some streaks and patches of pay-ore have been found above the 2100-ft. level, but it is intended to leave the 200 to 250 feet of ground below the 1750-ft. level as a sheet-pillar to protect the mine from caving or inundation. The next level, at 3000 feet, will be driven from the Combination shaft, for which a powerful man-hoisting engine has just been ordered. This is a Nordberg double-drum hoist to be operated electrically by a Westinghouse 450-hp. induction-motor through a single reduction of herringbone gears. Later, an ore-hoisting engine will be erected at this shaft; it will have a capacity of 4000 tons per day from as deep as the 4200-ft. level and will be operated by a 2000-hp. induction-motor capable of being overloaded to 4400 hp. The skips will hold 8 tons of rock and will be larger than any hitherto used, so as to decrease the proportion of ore that has to be broken underground. The Central shaft has been deepened to 2700 feet and levels are now being extended. The Combination shaft, which is 1700 feet away and well outside the stoping-area, is down to 2100 feet and will be deepened forthwith, so as to facilitate the completion of the necessary connections underground. The lowest stopes are at 1600 feet, leaving 1100 feet virgin, of which about 500 feet is believed to be workable at a profit. The main orebody has shortened from 2000 feet to 1400 feet, but the area of ore, which averages 84 feet in width, is still such as to give ample scope for large exploitation. It is evident that the management is hopeful in a sanely scientific way, and the improvement in the grade of the ore in the bottom of the mine justifies reasonable optimism. It is not often that a mine 'comes again,' but signs are multiplying that the Treadwell is one of this rare kind. We join with the mining community on this Coast in best wishes for a rehabilitation of this splendid enterprise.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Difficult Mine-Sampling

The Editor:

Sir—The sampling of cinnabar ores might be mentioned in connection with the letter contributed to your issue of March 17 by W. H. Storms.

As channel-samples cut from cinnabar ore are most unreliable the sampling of the Black Butte quicksilver mine in Lane county, Oregon, was accomplished by a method which subsequent furnace-recovery is confirming.

The formation is altered andesite in which particles of cinnabar are disseminated. The best ore lies on a wall which apexes along the ridge of Black Butte and dips with the northern slope of the mountain. The assay-values shade from the wall out toward the surface. In sampling the mine an arbitrary width of 10 ft. was assumed and a 3-ft. cut of that width was taken from the backs of all the drifts. After being crushed to 1¼ inch the ore was transported to the Scott furnace by aerial tramway. On its way to the furnace every twentieth bucket was dumped into a small Gates crusher, which reduced the ore to half-inch and delivered it on the sampling-floor. The tramway-buckets carried about 100 lb. and a day's run resulted in a sample weighing several tons. This was cut down in the usual manner and the pulp assayed by the distillation method.

As no more than enough ore for one day's run was allowed to accumulate in the loading-bin, it was possible to calculate from which particular part of a drift the day's sample came and the number of feet it represented. This method of sampling in conjunction with the furnace-recovery for the entire sampling-period gave results that were higher than returns from channel-samples which previously had been taken at 5-ft. intervals over the same ground.

EARL B. CRANE.

Cottage Grove, Oregon, March 20.

Mining Law

The Editor:

Sir—In your editorial columns of December 30, I see quoted Sec. 14261 of the California state mining law, which is there referred to as a much-needed provision, and under the head of 'Discussion' in your issue of January 13, 'Nil Desperandum' considers it a "bully" law. As a prospector who has followed the game for more than 34 years in practically all the Western mining territories and States, from Texas to Kotzebue Sound, from Mexico to Canada, I call it a super-freak. I consider the person capable of conjuring such a hybrid fully entitled to a medal. So far as I know, California was the first State to hatch this disqualification egg; but since then its legitimate offspring, in a somewhat degenerate form, has invaded this beautiful northern land. I hope there will be room in the Hall of Fame for the originator, as well as the imitator of the above law. I will try to show from personal experience how Sec. 14261 works in practice. A few years ago I was prospecting in the Sierra Nevada, in California, where I discovered a promising so-called 'blind' gold-bearing vein, after driving an adit some 20 ft. into the alluvial overburden. It being then late in the fall, and as that section is noted for heavy snows, I was obliged to go out. As there was no outcrop, I located one claim only, taking the precaution, however, to cover as much as possible all evidence of mineral by caving the roof of the adit, and burying float, etc., intending to locate additional ground the following season, if further prospecting would justify. I then mushed out. Circumstances over which I had no control prevented me from returning the following season. When my three-year sentence of disqualification expired, I found myself in Nome. I may or may not see that prospect again. Some other prospector may discover it. If not, and if there is a mine cached there, the State is a loser. I am punished. Let the State kill this 14261 thing and require the prospector who re-locates his claim to expend at least $300 in development work immediately after re-location to acquire title. Such a law would eliminate the claim-hog, benefit the State, and might occasionally be the means of bringing in a new mine, and at the same time punish the prospector.

NIGGER HEAD.

Livengood, Alaska, February 10.

The Propeller-Agitator

The Editor:

Sir—In your issue of March 24, 1917, I notice a communication signed 'An Old Subscriber,' in regard to the Devereux propeller-agitator described in your article on the Nickel Plate mill at Hedley, and also by Roscoe Wheeler, superintendent of that mill.

'An Old Subscriber' quotes from an article in the MINING AND SCIENTIFIC PRESS of September 17, 1904, describing a similar agitator, for the expressed purpose of preventing any of your readers from believing that this is a new device. Unfortunately, the name of the author of the communication quoted is not given, and I have not a copy of the PRESS of September 17, 1904, available, but I believe the agitator described is the De-

vereux agitator, and is the same as that with which the Nickel Plate mill has recently been equipped. This agitator, which consists of a propeller revolving horizontally in a tank a sufficient distance above the bottom so that the settled solids do not interfere with starting and used in conjunction with a baffle-board to prevent the contents of the tank assuming a rotary motion, was invented by W. B. Devereux in 1902, for the purpose of agitating slime-concentrate at the mill of the Melones Mining Co., and patent was applied for in January 1904. These agitators have been used continuously by the Melones Mining Co. since that time, but notwithstanding that fact, they are comparatively new to the public, as until recently their successful application has not been generally known. Agitation by means of a propeller is not a new idea, but the combination of a propeller, so situated above the bottom as not to interfere with the starting by the settled solids, and a baffle-board, formed the novelty of the invention. The machines were built at one time by the now defunct Fulton Iron Works, and it is quite possible that the article in question originated with them, but in any event, whoever the author, it is probable that the article is a description of the original agitators installed by the Melones Mining Company.

WILLIAM G. DEVEREUX.

Melones, California, March 27.

[We do not doubt the correctness of Mr. Devereux's surmise. It is altogether likely that the description of the agitator in our issue of September 17, 1904, did come from the source indicated.—EDITOR.]

Bonus System in Milling

The Editor:

Sir—Referring to the letter in your issue of March 17 on this subject, I believe this should have been called 'Wrong Bonus System in Milling.' The writer of that letter stated the principles on which the bonus system was based and then pointed out the effect of the same, which, no doubt, proved disastrous. Any person who has had any experience with bonus systems could see at a glance that the principles of the one under discussion were wrong and that the effects of same could have been nothing but disastrous. According to your correspondent, the bonus system paid a bonus only to the mill-man showing the highest tonnage crushed and only to the mill-man who produced lowest-grade tailing. Bonus systems based on the principle that only the men who produce the highest results should be paid a bonus, in most cases, as in the case referred to, produce dangerous competition and eliminate true co-operative team-work of the various men on the various shifts, for the simple reason that in order to earn the bonus they must defeat individuals on opposing shifts and the human tendency is to try to produce this defeat by any sort of means available, whether they be legitimate or not. If any man discovers an improvement in the process whereby he can increase the output, it would be entirely to his disadvantage to let the members of the opposing crew learn of this improvement, for then he would be really working against his own personal interest as far as receiving the bonus is concerned.

All successful bonus systems are based on the recognition of individual effort, but they are so designed and applied that they promote, rather than retard, co-operative team-work, and it is by the correct application of the right type of system that co-operative team-work is produced toward the ultimate prosperity of both the employer and the employee.

H. N. STRONCK.

Chicago, March 19.

Sulphur From Pyrite

The Editor:

Sir—With interest I have read, in your issue of March 17, M. G. F. Söhnlein's inquiries regarding recovery of sulphur from pyrite, and your discussion of the problem is illuminating. Mr. Söhnlein is correct in his assumption that pyrite itself may be used as source of heat in the production of sulphur from this compound. In Sweden and other countries where native sulphur does not occur but where large quantities of pyrite are available, a simple method of production has been developed. A furnace similar to a small lime-kiln has been used. Grate-bars are placed in the bottom and the pyrite in large lumps is piled loosely upon them. To ignite the charge in the kiln a layer of wood and shavings is placed on the grate, by which the initial heat is developed. Once ignited, the kiln will burn continually. At a suitable height on the kiln-wall is an opening, by which the sulphur-vapor can be withdrawn and condensed. From time to time the cinder is drawn from the grate-bars and fresh pyrite charged at the top. It is reported, that a kiln operating in this manner delivers half of the sulphur present in the pyrite, while only one-third is obtainable when pyrite is heated in a closed retort. As to the manufacture of the calcium hyposulphite, it is a simple undertaking. Wooden towers from 30 to 90 ft. in height and 6 ft. in diam. can be used for this purpose. The towers are provided with heavy wooden grates in the bottom. These towers are filled with limestone. The sulphur di-oxide, produced by burning sulphur, is admitted at the bottom, while water is kept continuously trickling down over the limestone. Thus calcium hyposulphite is produced, which is stored in suitable vats. The limestone is gradually consumed and must be replenished from time to time. Neither of these chemical processes are novel. They have been in practice for many years. The above method of producing sulphur has been used for hundreds of years in Sweden, and the method described of producing hyposulphite has been employed ever since sulphite paper-pulp has been manufactured.

J. W. BECKMAN.

San Francisco, March 20.

GOLD PRODUCTION in Oregon last year amounted to $1,861,796, being the output of 95 mines. The silver yield was 117,947 fine ounces.

THE ALASKA JUNEAU AND EBNER MINES, ALASKA.

Methods of Mining Big Orebodies

By ROBERT A. KINZIE

INTRODUCTION. At the present time, there is a great deal of interest in the mining methods that are to be adopted in the mines on the mainland near Juneau, Alaska. This awakening of interest is due to the recent financial prominence of the Alaska Gold Mines Co. and the Alaska Juneau Gold Mining Co., and also to the magnitude of the proposed operations and the low cost of mining estimated by the engineers in charge of the work.

The operations of the Treadwell group and the stoping experiments made in the Perseverance mine of the Alaska Gold Mines Co. pave the way for the mining methods that will ultimately be used in all of the large low-grade ore deposits in what is known as the Juneau Gold Belt. The work done on Douglas island has made available a large number of accurate data of methods and cost that can be utilized as a guide when discussing the possible methods and costs of mining the ore on the mainland. There is one most important fact to keep in mind when using these data: that the problem of removing the ore from the mixed slate and meta-gabbro bands in the vicinity of Juneau is a much more difficult matter than that of mining the remarkably uniform and homogeneous diorite intrusions of the Treadwell and adjoining mines.

The importance of designing and operating a method of stoping that, while safe, will be cheaper than that in use on Douglas island becomes imperative when it is realized that the recoverable gold-content of the ore from the Juneau belt is only about one-half that yielded by the ore of the Treadwell group.

The portion of the Juneau belt in which the principal mainland mines are situated extends from Sheep creek on the south to the valley of Salmon creek on the north, a distance of 5½ miles. While the zone of mineralization has a maximum width of 3000 ft. the workable orebodies are confined to the foot-wall portion, with a maximum width of about 900 feet.

The rock forming the foot-wall of the ore-zone is meta-andesite, locally known as 'greenstone,' which has been converted into chloritic schist at the contact with the foot-wall orebodies. The ore-zone is composed of bands of altered sediments, locally called 'black slate,' which have been intruded by dikes of meta-gabbro. These dikes are generally parallel in strike and dip with the slatey cleavage. The dip varies from 65°, in the Perseverance and Alaska Juneau mines, to 35°, in the vicinity of Mt. Juneau. The meta-gabbro dikes, as well as the black slate of the foot-wall country, have been crushed and sheared, and the crushed areas are highly mineralized.

Both the black slate and the meta-gabbro are cut by numerous stringers or small lenticular quartz veins. When the sulphides of zinc and lead are present, the general rule is that the gold content of the ore varies directly with the proportion of quartz, but when the sulphides are absent, the quartz is usually barren. Undoubtedly there is a distinct genetic connection between

the ore and the meta-gabbro dikes. When the stringers of quartz extend into the black slate to distances of 30 or 40 ft. from the meta-gabbro dikes, the galena and blende disappear and the rock becomes too poor to be mined.

The ore-zone has been cut by several large faults, the Silver Bow fault, which crosses the Alaska Juneau ground, being by far the most important, both with respect to its magnitude and possible economic effect. Next in importance is the Nugget Gulch fault, which can be traced from the summit of the ridge dividing the basins of Sheep and Gold creeks to the bed of Gold creek, a short distance north-west from the Ebner workings. It is along the line of this fault that practically all of the known orebodies in the different mines are found. When the faults have black slate on one or both walls, the slate has been badly crushed, thereby forming a 'gouge,' or clay band, from 3 to 30 ft. wide. This gouge will be an important factor when stoping methods are to be selected.

Contrary to generally accepted ideas, the gold in the ore is not uniformly distributed, as in the diorite dikes of the Treadwell mines, but is confined to nearly parallel bands. The ore in these bands forms elongated lenses and the bands themselves are separated from one another by waste. The maximum width of the ore-lenses is from 10 to 100 ft., while the intervals of waste separating them vary from 30 to 200 ft. In the so-called ore-bands, there are numerous tongues of waste that will have to be mined with the ore. I do not think that the entire width of the ore-zone (say, 300 to 900 ft. wide) can be considered as 'ore,' nor can any scheme of stoping that includes the mining of it as a whole be conducted at a profit, on account of the large amount of waste-rock that will have to be handled.

Considering the ore-zone as differentiated from the mineralized zone, there is no distinct hanging wall. The gold-content simply fades as the distance from the foot-wall greenstone increases, resulting in an area of practically barren rock, made up of black slate and dikes of meta-gabbro between the ore-zone and the schist hanging wall of the mineralized zone.

The best method of stoping for any particular mine is the one by which the highest extraction of ore can be made at the lowest cost. Here the word 'stoping' is used in its broadest sense, and includes all necessary development and preparatory work.

In the mines near Juneau the low gold-content eliminates at the outset any consideration of those methods of stoping in which timber is used to support the ground.

In a broad sense the Juneau ore deposits can be considered as lodes—having an average dip of 55°—of known width, great length, and unknown depth. It will, therefore, be seen at a glance that they differ in the most essential details from the disseminated-chalcocite deposits of the West and resemble closely the ore deposits of the Homestake in South Dakota and the Treadwell in Alaska. A large proportion of the ore cannot, however, be mined by the methods in use in the two mines cited, for physical as well as economic reasons.

The stoping methods adopted will vary in the same mine on account of the physical characteristics of the ore, that is, whether the ground to be stoped is meta-gabbro, mixed meta-gabbro and slate, or slate. It is a fortunate coincidence that the gold-content of the different classes of ore varies directly with the probable cost of mining, and this means that the richest and most consistent orebodies are in the meta-gabbro, while the poorest and most erratic are in the slate.

As all of the known orebodies will be developed by means of adits driven at depths varying from 1000 to 2000 ft. below the outcrop, it is axiomatic that any method of stoping will depend for its success on the effective ventilation of, and easy access to, all the working-faces of the mine and the efficiency of the methods of transporting the broken ore from the stope to the mill-bins.

Before the work of 'blocking out' the ore and starting the stopes can begin, a raise or shaft should be driven to connect the adit with the surface. This shaft should be used only for ventilation and for the transportation of men and supplies, and be excavated—if possible—in the hard and tough meta-andesite of the foot-wall, thus ensuring its permanence and freedom from accidents on account of the movements of ground due to stoping operations. It is probable that the vertical distance between levels will vary from 200 to 300 ft., depending on the character of the ore to be mined, that is, whether meta-gabbro or slate predominates. This being the case, manway-raises should be driven connecting the levels every 400 ft. As the raises are being driven, short intermediate drifts should be run at intervals of about 30 ft. These short drifts would connect with the stopes when they reach each succeeding intermediate level and would serve as man-ways. By running the stub-intermediate drifts when the manway-raises are put up, the danger of breaking ladders and pipes by blasting, when connecting from the stopes to the manway-raises, is obviated. If the main shaft is placed near the middle of the orebodies, the best position for the first raise to be used for transferring broken ore from the various levels to the main-haulage level is parallel with and about 50 ft. from the shaft. This ore-way need only be run to the top level. To avoid packing of ore in the ore-ways, the descent of rock should be controlled by by-pass gates at intervals of, say, 300 ft. If these gates are placed on each level and made part of the station ore-bin, much trouble and expense will be saved. It is quite probable that there will be some seepage of water through the ore-ways after the upper levels have been stoped and caved, so as to increase the liability of packs or hang-ups in the ore-ways. For this reason alone it is desirable that intervals not longer than 300 ft. should be allowed between the control-gates. If the ore-ways are driven in the foot-wall, it will be a simple matter to drain all the water from the upper stopes.

The gold-bearing meta-gabbro ore is a tough homogeneous material, free from cracks and slips when not in the close proximity to faults, and affording, therefore,

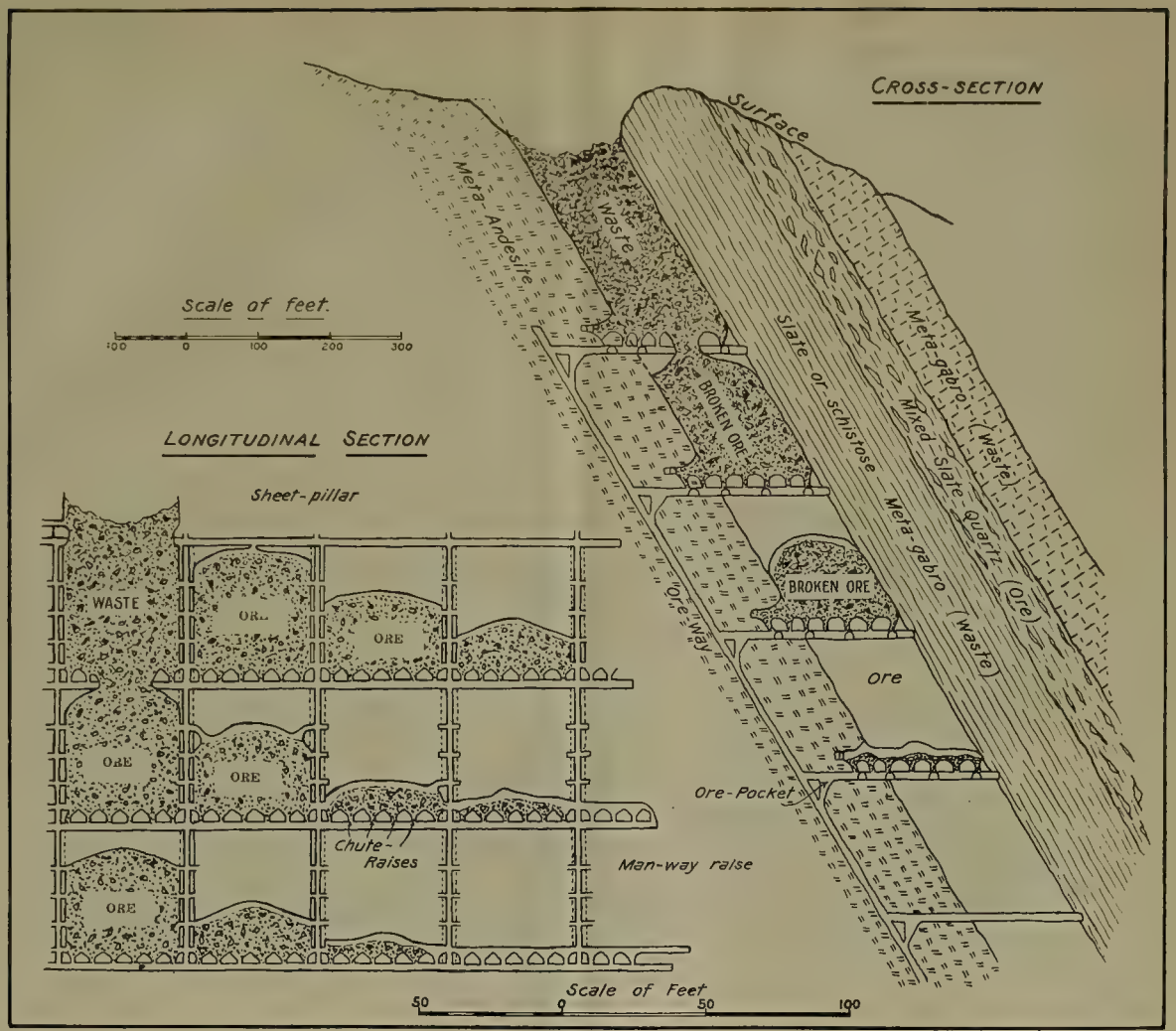

FIG. 1. SHRINKAGE METHOD.

excellent standing-ground. It will not cave or slough if ordinary care is exercised by properly trimming the stopes after blasting.

The methods used at Treadwell for stoping the ore and reclaiming the pillars are peculiarly adapted to the mining of the meta-gabbro ore, particularly when the 'bulldozing-chamber,'as now perfected, is considered as part of the scheme of mining.

It will be noted that in all the descriptions of stoping methods that follow, the so-called bulldozing-chamber is a most important factor. It was adopted in the mines on Douglas island to reduce the cost of bulldozing and sledging in the stopes and also to purify the air in the principal working-places, by reducing the fume due to blasting and also to cut down the number of men working in each chamber. Any mining engineer knows the lost time, accidents, and reduction of efficiency due to the above causes, and will be interested to know that the bulldozing-chamber has been the means of reducing the above evils to a minimum. This chamber can be used to advantage in conjunction with any of the various forms of the shrinkage or caving methods of stoping. It consists of a chamber cut in the foot-wall or in the sides of a stope, and is connected to a haulage-level by means of chute and man-way raises. The chute-raises are used to transfer the broken ore to the haulage-system and the man-way-raises for means of communication and ventilation. There should always be two means of ingress and egress to the chamber on account of the liability of a rush of rock blocking the passage to the man-way or ventilating raise. If there is but one means of communication, the chamber should be cut wide enough to insure a safe passage at all times. However, since good ventilation is such an important factor, two means of communication should be provided if possible. The side of the bulldozing-chamber facing the stope is cut away and connected with the stope throughout its entire length. The height and shape of the roof of the chamber, on the stope side, is regulated by the character of the ore handled and should be so proportioned that the broken ore in the stope will

flow freely to and over the entrances to the chute-raises. This allows the powder and block-hole men to work in a protected place, while breaking the large pieces of ore to the desired size. In the Treadwell mine, where caved ore is being handled, the bulldozing-chambers are from 50 to 100 ft. long, 20 to 30 ft. wide, and the height will vary from 9 ft. in the back part of the chamber to 50 ft. where it connects with the stope.

While describing various methods of stoping I shall ask the reader to keep in mind the fact that their ultimate success depends on the work being started on the top level and proceeding downward as the ore is exhausted, allowing the walls to cave and form a mattress over the broken ore below. Although they will permit of stoping to a limited extent from any level, the final success of the system absolutely depends on starting stoping at the upper portion of the orebody and working downward, not starting at the level of the main haulage-way and working upward. It would, of course, be possible after the shaft and ore-ways are completed to carry the stopes through to the surface from the main haulage-level, but this would tie up an unwarranted sum of money on account of the immense tonnage of broken ore that would remain in the stopes until the whole operation was completed. This tonnage would amount to at least 65% of all the ore broken, as it is only possible to draw off 35% of the broken ore and leave sufficient head-room for the men to work. Furthermore, in the slate stopes, a long continued exposure of the hanging wall to the air would cause it to cave, thus mixing with the broken ore a prohibitive amount of waste rock.

Even when the above suggestions are carried out, there are certain conditions and limitations that restrict the application of the shrinkage system of stoping and, to my mind, these conditions exist to a marked degree in the Juneau belt.

It is axiomatic that, before starting any form of caving or shrinkage stoping, there must have been completed an accurate survey and geological study of the orebody and that the permanent centre-line of all stope-pillars has been selected so that the pillars on each level will be in a vertical plane, no matter how deep the workings are carried. There is a great temptation to change the position of certain pillars on account of their containing ore richer than the average. The yielding to this temptation has been the most fertile cause of the failure of this form of stoping in a large number of mines.

Where wide bodies of ore are being extracted, the next most frequent cause of trouble is the failure properly to support the walls after the ore has been drawn. If the angle of dip is more than 45° the stopes can often be filled with waste from the surface by simply allowing the hanging wall to cave and follow down on top of the broken ore as it is drawn. This method works fairly well where the orebody is wide, down to a depth of 1000 ft., but it is extremely hazardous to depend on it for greater depths, because the filling has a tendency to pack and hang up—then, when a large open space has occurred, to let go suddenly and carry away all supports in the stopes below. If the angle of dip is less than 45° the stopes will have to be filled by some other method.

When the dip of the orebody is less than 60° the efficacy of any shrinkage method of stoping is materially reduced and should not be adopted unless there are other conditions that offset those due to dip. There is a mistaken idea that the broken ore in a stope will flow freely to a chute or other opening. As a matter of fact the broken ore drawn through any one chute can be represented by a cylinder whose diameter is the same as the opening of the chute and whose height is the depth of the broken ore in the stope. It is for this reason that the chutes should be as close together as possible and that their openings in the bottom of the stope should be so flared that the stope-opening of any one chute would intersect those of its neighbors. Also when the dip is less than 60° the levels have to be run at shorter vertical intervals, and this added cost will often counter-act the economies of any shrinkage or a combination of shrinkage and caving method of stoping.

When proposing and describing the following methods of mining, as applied to the low-grade meta-gabbro slate orebodies in the vicinity of Juneau, I do not lay any claim to originality, but do say that, in their modified form, they are in my opinion suitable for the work for which they are recommended. This opinion is not based on theory alone, for all four methods have been tried in practice in a number of mines under my direction, and some of them, in a modified form, are now being extensively used in the district under discussion.

1. Shrinkage (as in use on Douglas island). For stopes in compact and uncrushed meta-gabbro. See Fig. 1 and 2.

2. Combined shrinkage and stoping and caving of pillars. For stopes in meta-gabbro where the ground has been somewhat crushed or faulted, or in mixed meta-gabbro and slate. See Fig. 3, 4, 5, and 6.

3. Combined shrinkage and caving of pillars. For stopes in crushed meta-gabbro or slate, when the ore will not stand exposure to the air without caving. See Fig. 7.

4. Combined shrinkage and caving. For stopes in heavy ground, where the foot-wall is good and well defined. See Fig. 8, 9, and 10.

First Method. This method of stoping is applicable to the orebodies in compact and uncrushed meta-gabbro, lying next to the meta-andesite foot-wall and to a less extent to the more or less crushed meta-gabbro orebodies situated at a distance from the foot-wall, but having walls of fairly good standing rock. While the method can be used to advantage when the orebodies have widths of 30 or 40 ft., the most economical stoping-width is from 100 to 120 feet.

Since the dip of the meta-gabbro orebodies will average 55°, the most economical vertical distance between levels is taken as 200 ft. This spacing of levels can, of course, be changed to suit the varying conditions in the mine. If the distance is increased, it means a less development cost per ton of ore stoped, but on the other hand it ties up a larger amount of ore in the form of broken ore in

stopes for a time varying directly with the increase in the height of the stopes, because the miners employed in the stopes work on top of the broken ore and, since only 35% of the ore can be drawn and preserve the desired working conditions, it means that 65% of the cost of stoping must be charged against the broken ore remaining in the stopes until such time as the stope is carried up to the next higher level and completed, when all the broken ore can be drawn.

If the height of stoping is decreased, it means an increased development cost per ton of ore stoped, for the development and preliminary work is practically the same, irrespective of the distance between levels.

When the orebody has been reached and its width determined by a cross-cut from the main shaft, the first work is the connecting of the level with the main transfer-chutes or ore-ways and the starting of a foot-wall drift in opposite directions from the main cross-cut. It is of prime importance that the foot-wall drift be kept on the foot-wall, thus defining one limit of the orebody, for the reason that the position and direction of the other haulage-drifts and raises, as well as the intermediate drifts and bulldozing-chambers, are determined from it.

FIG. 12. DOUBLE-TRUCK SIDE-DUMP CAR. CAPACITY 130 CU. FT.

At intervals of 400 ft. manway-raises are put up from the foot-wall drift and connected with the next higher level. These raises are used as means of communication and ventilation, while the development work is in progress, and afterward as means of ingress and exit to and from the stopes. As the raises are driven, stub-drifts (15 ft. long) are run at intervals of 30 ft. and the manway-raises are equipped with permanent ladders, air and water-pipes, and station-platforms are built at the level of each stub-drift on both sides of the raise.

When the foot-wall drift is far enough advanced to determine the strike of the foot-wall, parallel drifts are started from the main cross-cut with 60 ft. centres. It is desirable to make these large, since all of the development work, with the exception of the foot-wall drifts and the bulldozing-chambers, is in ore. In the Treadwell mine the dimensions of the drifts and cross-cuts are 7 by 9 ft. and the manway raises are 5 by 7 feet.

All the drifts should be connected by cross-cuts at intervals of at least 400 ft. In addition to furnishing ventilation, they afford an excellent opportunity for accurate sampling.

As the stope-pillars on each level are laid out so that their centres will lie in the same vertical plane, at right angles to the strike of the orebody, the position of the chute-raises is known and they should be put up as the drifts progress. The chute-raises are 5 by 6 ft. and run with an inclination of about 60°. The height of the raise depends on the thickness of the pillar left between the bottom of the stope and the level. As soon as the chute-raises are completed, the chutes are constructed. In the foot-wall drifts, the chutes are all on the foot-wall side and are spaced 20 ft. centres; in the other drifts and cross-cuts, they are spaced 30 ft. centres, but are put up from both sides of the drifts and are staggered, so that each interval is really 15 feet.

The work of stoping is started by driving a drift at the level of the floor of the proposed stope, from the manway-raise and connecting it with the top of the nearest chute-raise. This intermediate is continued until at least two or perhaps three chute-raises are connected. The intermediate drift is then widened out until the entire width and length of the stope is cut out and connections made with the tops of the chute-raises previously excavated. If the ground stands well, the chamber will average about 7 ft. in height—if the ground is bad, the roof is arched, the height and position of the arch depending on the character of the ground. As the cutting-out of the stopes progresses, the tops of the chute-raises are widened by machine-drills working on a tripod or by hammer-drills set up in the raise. Thus, the final shape of the chute-raise resembles a funnel, the outer edge of the rims of each parallel row of chute-raises in-

tersecting. This allows a larger area of the stope to be drawn from a single chute and greatly reduces the work of 'picking in' as the stopes are drawn. On account of the men working and blasting on the surface of the broken ore, it packs into a compact mass, and when it is drawn, it flows to the chute through a cylindrical space, the end area of the cylinder coinciding with the area of the top of the chute-raise, instead of the inverted cone that would be formed were the broken rock loose and free to flow. The stope is increased in height by drilling and blasting from the back and along the sides of the pillars.

The drilling can be performed by either reciprocating or hammer-type drills, the footage being the same for both classes of machines, but the cost is decidedly in favor of the hammer-type. Close attention and super-

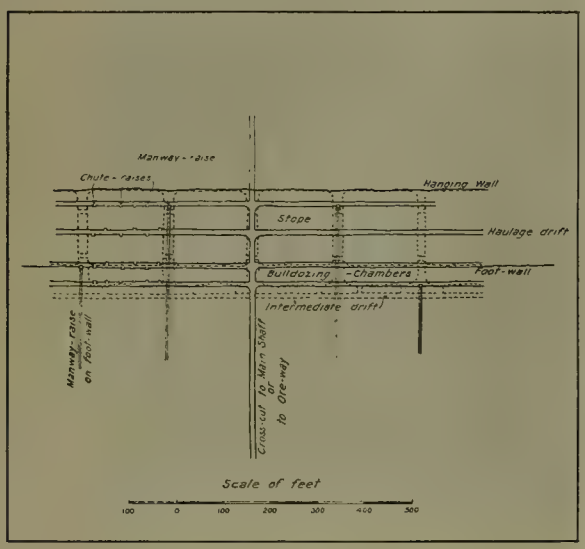

FIG. 2.

vision should be given to both the recorded results and the manner of performing the drilling, and the men in the mine should know the results of not only their own work, but of similar work in the same mine or elsewhere. The holes should be drilled to a depth of about 7 ft. and be so pointed that the bottom of the hole will be about 3 ft. from the back of the stope. These dimensions will vary from week to week in the same stope and the miner will learn from experience the best-breaking depth for any particular rock. The holes should be drilled at a fairly flat angle, for the object is not only to break a large tonnage of rock, but to so blast it down that it will break in pieces that can readily be handled either in the stopes or bulldozing-chambers. The unaltered metagabbro is an exceedingly difficult rock to break with hammers. It is, therefore, advisable to so regulate the drilling and blasting that only such pieces of rock as will readily pass through the stope and thence into the bulldozing-chambers will be excavated. If large masses of rock are broken, it means more men in the stope and more powder-fume, to say nothing of the interference with the regular drilling-crews and the added danger of a ragged 'back' and an increased number of men exposed to the risk of accident.

As the stopes grow in height, they connect in succession with the stub-drifts driven from the manway-raises at the time they were put up, and in the same order the lower stub-drifts are blocked with broken ore until such time as the surface of the broken rock again reaches its level in the process of being drawn from the stope after it has been carried up to the next higher level and completed. A detail of construction in connection with the manway-raises and stub-drifts that has an important bearing on the drilling efficiency in the stopes, is to carry the main compressed-air pipe *down* the manway-raise, leaving a connection opposite each stub-drift, instead of up the manway-raises, as is ordinarily done. When the pipe comes down the raise, any water in the air can easily be drawn off at the bottom end and, as the stope gains in height, the lower sections of the pipe can be removed and used in other places. Also the danger of broken pipes, due to blasting in the stopes or to objects falling down the shaft, is greatly reduced.

The work of stoping by blasting down the back, breaking up the larger pieces of ore and drawing off one-third of the broken ore, is continued until the apex of the arched back of the stope breaks through into the next higher level. The method of breaking through from an uncompleted to a completed stope is clearly shown in Fig. 1. The machine-drill men work from the centre of the stope in all directions toward the walls under the protection of the sheet-pillar, gradually enlarging the opening between the stopes by drilling inclined holes and blasting the ore from the sides of the opening until about 85% of the ore left between the bottom of the level and the sill-floor of the stope above has been recovered.

In some instances, it may be possible to recover the stope-pillars, but on account of the low grade of the ore and the danger attached to its removal, it may be found more economical to leave them in place.

If the hanging wall is good enough to prevent caving while the stope is being carried up, it is possible to recover about 75% of the ore by this method of stoping.

After the stope has been connected with the next higher level, all the broken ore in the stope can be drawn, thus allowing the broken waste that caves from the walls to fall on top.

The proportion of broken ore in the stopes that can be drawn through the bulldozing-chambers and stope-chutes will depend on the dip of the foot-wall, but in any event there will be a small proportion of the broken ore that will not be recovered until the stope from the next lower level breaks through and the bottom of the stope is removed. In the Treadwell mine a large part of the broken ore in the corners and between the chutes is shoveled into the chutes, but it is dangerous work and I am doubtful if it will be found economical to follow this method in the mines on the mainland.

(To be Continued)

The Engineer Enlisted Reserve Corps of the United States Army

The Engineer Corps in our army corresponds to the famous Royal Engineers of the British army, that branch of the service which builds roads and bridges, fortifications for defense and tunnels for offense, and various other duties. To them is due the wonderful system of field-fortifications that enabled the British to withstand the enemy's onslaught during the last two years and a half. The United States of America is now at war and there is no time to train engineers for such work; the men of the Engineer Corps for the new armies must be taken from the ranks of civil, mining, mechanical, and electrical engineers, as well as machinists and other skilled trades.

The Engineer Corps of the army needs topographical surveyors, sketchers, and instrument-men for the highly important technical work of making contoured military maps of the field of war, laying out battle positions, roads and highways, systems of trenches, and drainage lines.

Topographical draftsmen are wanted to trace the field-maps of surveyors. Mechanical draftsmen will find employment in making drawings of armored trains, armored trucks, and other mechanical devices used in war. Photographers are needed for the reproduction of maps in connection with photographic surveys.

TRIPOD WIRE ENTANGLEMENT

TRENCH AND UNDERGROUND APPROACH

BEGINNING TO CONSTRUCT A FLOATING BRIDGE

THREE CANVAS BOATS IN PLACE

Lithographers, zincographers, blueprint-men, and others skilled in the various processes of reproducing photographs and drawings, are required to reproduce and publish engineer-maps of battlefields and the general theatre of war operations.

Miners and quarry-men skilled in handling explosives and in underground-mining form one of the most important elements in the personnel of the Engineer Corps. The engineers dig the tunnels under the enemy's trenches and destroy them with dynamite and other high explosives. They dig the underground galleries and bomb-proofs that conceal and protect the armies occupying their own trenches.

Military demolitions such as the destruction of bridges, bridge-piers, railroads, and road-beds, as well as land-mines, are effected by the Engineer Corps.

Carpenters and woodworkers of all classes are needed for the timberwork in trenches and bomb-proofs.

Millwrights and bridge carpenters are especially valuable in the construction of bridges, which the Engineer Corps must build rapidly and of sufficient strength for the passage of army trains, great guns, and for the rapid transport of marching troops over streams and ravines.

Blacksmiths handle the ironwork, including the manufacture of forgings of various kinds in connection with bridge-work, trench-work, military demolitions, and also in the repair of entrenching tools, which the Engineer Corps is called upon to supply to the fighting army.

Plumbers and pipe-fitters lay the pipes in connection with sewage and water-supply systems for the trenches and fieldworks.

Electricians wire the trenches for electric lighting, operate the electric-light plants and power-plants, and operate the great search-lights and other electric illuminating devices used to light the area in front of the trenches. The electrification of barbed-wire entanglements forms a vital element in the defence of modern trenches. For this work electricians are required. Steam and gas-engine operators, fire-men, and machinists are needed in connection with the construction and operation of power-plants, steam and electric pile-drivers, the great caterpillar-trucks, and machine-shops.

Axe-men and millwrights work on the spar-bridges and clear space in front of trenches of trees, brush, wire entanglements, and timber structures.

Boat-men, riggers, and caulkers handle the floating bridge-equipage, which engineers carry in their trains and with which they bridge the widest streams.

Masons and concrete-men construct the permanent work on trenches and gun emplacements, sewage-lines, water-supply, and revetments.

Horse-shoers, farriers, packers, teamsters, and saddlers are needed in connection with the operation of wagon-trains and pack-mule outfits. Every engineer company has a section of 24 mounted men, and these, of course, are picked from among such as know how to ride and understand handling horses or mules.

Clerks, of course, are needed also, as there is a vast amount of clerical detail.

Cooks and assistant cooks are a vitally important element, for obvious reasons, in the personnel of an efficient and contented engineer company.

Musicians and signal-men are neded in every company to blow calls, act as messengers, and do the signalling.

There is hardly a phase of civil engineering-practice that is not carried on during the operations of a company of the Corps of Engineers in war-time.

The illustrations shown herewith are actual photographs of military engineering work conducted by the Corps of Engineers in the field.

The classes of men required may be briefly summarized as follows:

a. Topographical surveyors and sketchers, including instrument-men
b. Draftsmen, topographical and mechanical
c. Photographers and blue-print men
d. Lithographers and zincographers
e. Quarry-men (skilled in explosives)
f. Miners
g. Skilled carpenters
h. Bridge-carpenters
i. Blacksmiths
j. Plumbers and pipe-fitters
k. Electricians
l. Enginemen, steam
m. Enginemen, gas
n. Fire-men
o. Machinists
p. Masons
q. Caulkers
r. Riggers
s. Expert axe-men
t. Boat-men
u. Horse-shoers
v. Farriers
w. Packers
x. Teamsters
y. Saddlers
z. Cooks
aa. Assistant cooks
bb. Clerks
cc. Musicians
dd. Signal-men, as required by Army Regulations

An Engineer Company is composed of 109 engineer-soldiers, graded as follows:

3 Sergeants, 1st Class	1 Horse-shoer
1 Supply Sergeant	2 Buglers
12 Corporals	1 Mess Sergeant
2 Cooks	6 Sergeants
59 Privates	1 Saddler
1 First Sergeant	19 Privates, 1st Class
1 Stable Sergeant	

Sergeants must be at least 30 years old and have sufficient education to perform the duties of the grade, and must hold, in civil life, a position equal to or of the same importance as overseer in the Engineer Department of the Army, and shall be expert in one or more of the special qualifications listed above.

Corporals must be at least 25 years of age and must hold, in civil life, a position equal to or of the same importance as foreman in the Engineer Department of the Army, and shall be expert in one or more of the special qualifications listed above.

Privates must have one or more of the qualifications in the trades listed above.

The rates of pay are as follows:

	Per month
Master Engineer, senior grade	$75
Master Engineer, junior grade	65
Regimental Sergeant Major	45
Battalion Sergeant Major	45
Regimental Supply Sergeant	45
Battalion Supply Sergeant	45
Color Sergeant	36
Sergeant Bugler	40
First Sergeant	45
Mess Sergeant	36
Supply Sergeant	36
Stable Sergeant	35

	Per month
Sergeant, 1st Class	$45
Sergeant	36
Corporal	24
Cook	30
Bugler	15
Horse-shoer	30
Saddler	21
Wagoner	21
Private, 1st Class	18
Private	15

In addition to the pay, all subsistence, equipment, uniforms, and transportation are furnished by the Government.

The War Department desires to secure immediately a large enrollment of enlisted men in this Corps. All enrollments are desired for war service and none will be accepted for less than the period of the War. The recruiting office for the Engineers Section Reserve for Central California is at 204 Pine street, San Francisco, California, and is open every day, including Sunday, and until late at night. As soon as qualified men are enlisted, they will be assigned tentatively to engineer companies, whose personnel will be called later into active service, armed, equipped, and trained as their services are needed at the front. Ten thousand engineers should be raised in California alone, and of these a large number should be secured from among those engaged in engineering and similar occupations in the vicinity of San Francisco bay. Suitable men are urged to make application, either by mail or in person, to one of the following officers:

District Engineer Officer, 204 Pine St., San Francisco.
District Engineer Officer, 723 Central Bdg., Los Angeles.
District Engineer Officer, 602 Burke Bdg., Seattle.
District Engineer Officer, First District, 806 Couch Bdg., Portland.
District Engineer Officer, Second District, 321 Custom House, Portland.
District Engineer Officer, Third District, 405 Custom House, San Francisco.
District Engineer Officer, Eureka, California.

or, to any officer of the Engineer Section of the Reserve Corps, who have already been commissioned or recommended for commission, all of whom are authorized to secure applications.

The following is a list of reserve engineer-officers residing on the Pacific Coast already commissioned or recommended for commission:

CALIFORNIA

Major Seeley W. Mudd, 2232 Harvard Boulevard...Los Angeles
Major Geo. S. Binckley, Central Bdg.....Los Angeles
Major Wm. A. Cattell, Foxcroft Bdg.....San Francisco
Major H. H. Wadsworth, 405 Custom House.....San Francisco
Capt. Carl A. Heinze, 1415 W. 49th St.....Los Angelees
Capt. John A. Griffin, 428 E. 52nd St.....Los Angeles
Capt. F. J. Fitzpatrick .....Fort Rosecrans
Capt. Walter H. Adams, 1661 Rose Villa St.....Pasadena
Capt. K. D. Schwendener, 2158 W. 29th St.....Los Angeles
Capt. J. L. Bacon, 1101 American Nat. Bk. Bdg.....San Diego
Capt. Delmar S. Clinton .....Mill Valley
Capt. C. R. Adams, 912 Griffith-McKenzie Bdg.....Fresno
Capt. Carl E. Grunsky, Jr., 57 Post St.....San Francisco
1st Lt. William Hague .....Grass Valley
1st Lt. C. A. Meyer, 633 W. 18th St.....Los Angeles
1st Lt. Ross Henry Rock, 1443 W. 37th Drive.....Los Angeles
1st Lt. C. C. Bartlett, P. O. Box 308.....Corona
1st Lt. Kirby B. Sleppy, 1019 Florida St.....Los Angeles
1st Lt. Earl W. Fassett, 723 Central Bdg.....Los Angeles
1st Lt. E. E. Schliewen, 927 Gratten St.....Los Angeles
1st Lt. D. J. Young, 935 6th St.....San Diego
1st Lt. Wm. P. Belcher, 405 Custom House.....San Francisco
1st Lt. Charles H. Lee, 1103 Central Bdg.....Los Angeles
1st Lt. E. L. Norberg .....Burlingame
1st Lt. Blaine Noice, 5436 Carlton Way.....Los Angeles
1st Lt. F. L. Weisenheimer, 405 City Hall Annex..Los Angeles
1st Lt. R. E. Whitaker, City Engr's Office.....Los Angeles
1st Lt. Guy B. Donald, 3942 Walton Ave.....Los Angeles
2d Lt. Happer K. Phelps, 731 Wells Fargo Bdg..San Francisco
2d Lt. E. D. Clabaugh, 115 So. Olive St.....Anaheim
2d Lt. Wales MacPerdue, 2734 W. Ave. 31.....Los Angeles
2d Lt. C. F. Toklas, Union League Club.....San Francisco
2d Lt. V. H. Bell .....Calexico

OREGON

Capt. W. D. Peaslee, 125 East 11th St.....Portland
Capt. Henry M. Parks .....Corvallis
Capt. J. T. Kelly, Jr., 711 Pittock Block.....Portland
1st Lt. K. J. Zinck, Box 929.....Portland
1st Lt. John G. Kelly, Jr., 711 Pittock Block.....Portland
1st Lt. C. M. Hurlburt .....Hood River
1st Lt. J. P. Growdon, Pittock Block.....Portland
1st Lt. L. A. Henderson .....Hood River
2d Lt. Paul S. Jones .....Hermiston
2d Lt. Wm. E. Dickinson, 416 Couch Bdg.....Portland
2d Lf. S. J. Benedict, 2651 49th St., S.E.....Portland

UTAH

Lt. Leslie W. Nims, % Utah Power & Light Co..Salt Lake City
Lt. Clarence C. Jacob, 421 Federal Bdg.....Salt Lake City

WASHINGTON

Major S. H. Hedges, 432 Central Bdg.....Seattle
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Capt. Alfred B. Lewis, 310 Burke Bdg.....Seattle
Capt. John Harisberger, 4015 4th Ave., N.E.....Seattle
1st Lt. C. I. Signer, 1702 Yew St.....Olympia
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SULPHATE OF AMMONIA to the extent of 500,000 tons per annum could be recovered from the coal now being coked in bee-hive ovens in this country, by the general adoption of by-product coking. The waste of materials useful for munitions of war as well as for constructive industry through the continuance of bee-hive coking in America may be appreciated when it is realized that the present loss of these valuable products exceeds the total consumption of such material by Germany in the war she is waging.

ZINC SULPHATE is not only a preservative of wood, but also of leather and other organic matter. A practical use of it is to saturate the soles of shoes and boots with a moderately strong solution of the salt. Thus treated the sole-leather resists wear to an extraordinary degree. Fabrics saturated in zinc-sulphate solution and then dried are resistant to fire, that is, though they will char on being heated, they will not transmit the flame by becoming ignited.

Characteristics of Magmatic Sulphide Ores

By C. F. TOLMAN, Jr., and AUSTIN F. ROGERS

*The term 'magmatic deposit' should be limited to segregations of ore-minerals that take place under the influence of, or closely connected with, the molten stage of the parent rock. Ore deposition accompanied by destructive pneumatolytic action, or when formed by the agency of hydro-thermal solutions, is not to be classified as magmatic, even though closely related to or closely following the magmatic period. The latter class of deposits is connected with acid rocks, while the typical magmatic deposits are confined to basic rocks. Contrary to general opinion, the magmatic sulphides are formed by replacement of the silicates after the solidification of the igneous rock. Notwithstanding this, the term 'magmatic ore deposits' is retained for the types of ores described in this paper, because they have a close genetic relation to the intrusive rock in which they occur, and because they are formed within the magmatic stage as herein defined. Regardless of any theory as to their genesis, however, these deposits have definite and easily recognizable characteristics, which distinguish them from all other types of ore deposits. The characteristics of the magmatic sulphide ores, as brought out by our study, may be summarized as follows:

(1) They occur in sub-silicic rocks of the norite, gabbro, peridotite, or related families.

(2) In most occurrences the containing rock is either dominantly sub-silicic, with minor amounts of complementary per-silicic differentiates (Insizwa), or occurs as lenses of mafic rock in a large granitic intrusion (Golden Curry).

(3) The sub-silicic rock occurs generally as small dikes, sills, or stocks, and rarely as a large laccolith (Sudbury).

(4) In most cases the ore-bearing rock has undergone marked differentiation, and the differentiated portions are sharply separated and do not grade into each other (Ookiep).

(5) The ore may occur in any variety of rock produced by differentiation, but in any one locality the ore shows marked preference for certain types of rock, and occurs sparingly in others (Ookiep).

(6) Pegmatite and aplite dikes often cut, and are therefore later than the orebodies (Erteli).

(7) The ore is generally segregated at the margins of the intrusives, but occasionally occurs as lenses or tabular ore-shoots well within the intrusive magma (Engels). In sills, the ore is usually at the base of the intrusives (Insizwa); in dikes, it often is formed along the foot-wall (Sohland), or as columnar or irregular shoots occupying the entire width of the dike (Copper Cliff).

(8) Very often the ore is concentrated in those portions of the intrusive which have suffered brecciation during intrusion (Sudbury).

(9) The ore migrates only a short distance into the adjacent rock, from a few inches to a few score of feet at most (Sudbury).

(10) The 'offset' deposits, formed in dikes at some distance from the main intrusive, are accompanied and cut by veins carrying ore and gangue minerals of hydrothermal origin (Sudbury).

(11) There is no essential distinction between the sulphide group and the magnetite-ilmenite group as to the origin or the relation of the ores to the silicate minerals. In all the magmatic ores examined, ore deposition takes place at the close of the magmatic period.

(12) There are two general classes of the magmatic sulphide ores: (a) pyrrhotite-chalcopyrite deposits, and (b) chalcopyrite-bornite deposits.

(13) The so-called pyritic intrusive ores are not magmatic.

(14) The principal ore-minerals of the magmatic period include magnetite, ilmenite, hematite, pyrrhotite, pentlandite, chalcopyrite, and bornite.

(15) Pyrrhotite and bornite have not been found together in magmatic ores.

(16) Pyrite is not a typical magmatic mineral.

(17) The ore-minerals are formed at a late magmatic stage by a partial replacement of the silicate minerals. The ores surround, embay, and cut all the earlier silicates. They penetrate the cleavable minerals. They occasionally occur as sharp veinlets which lead out from the larger sulphide masses. Selective replacement is shown by the preservation in the ores of an original graphic texture of the rock.

(18) There is a definite order of formation of the principal magmatic ore-minerals. This order is as follows: magnetite-ilmenite (intergrowth), hematite, pyrrhotite, pentlandite, chalcopyrite, and bornite.

(19) There is evidence of the replacement of one magmatic ore-mineral by another.

(20) Euhedral magnetite and probably other minor accessories occurring in euhedral crystals, such as apatite, zircon, titanite, etc., are also formed at a late magmatic stage.

(21) There is clear evidence of the magmatic alteration of pyroxene to hornblende prior to the introduction of the ore-minerals.

(22) Hydrothermal alteration, although seldom lack-

*Abstract: 'A Study of Magmatic Sulphide Ores,' 76 pp., 20 plates and 7 text-figures; Leland Stanford Junior University Publications, 1916.

ing in magmatic ores, is relatively insignificant, and is distinctly later than the magmatic ore period. The silicates of the hydrothermal period include tremolite, anthophyllite, sericite, chlorite, and serpentine. These secondary silicates often replace the magmatic ore-minerals in veinlets and in sharp lath-shaped crystals without causing any change or migration of the ore-minerals.

(23) The attention given these alteration-products in order to determine their relative age, may have produced an erroneous impression as to their relative abundance. In most of the ores studied they are present only in minor amounts. Many of the magmatic ores are as free from alteration products as the average unmineralized igneous rock.

(24) A minor amount of rearrangement, however, consisting in the production of microscopic crystals of pentlandite and chalcopyrite of the second generation, has been detected in the pyrrhotitic ores. In the chalcopyrite-bornite ores there has been some migration, resulting in the formation of minor amounts of covellite, chalcocite, and chalcopyrite of the second generation. This alteration is only prominent where there has been an abnormal development of sericitization.

(25) The rôle of mineralizers in magmatic differentiation has not been sufficiently emphasized. The crystallization of the early-formed minerals in the magma involves the complementary process of the 'squeezing out' of the residual fluid. This process is not merely a mechanical one, but is also due to gaseous extraction.

(26) The typical magmatic deposits, unaccompanied by high-temperature alteration, with the exception of magmatic hornblende, are chiefly developed in basic rocks. Ore deposits genetically related to per-silicic rocks show intense rock alteration, probably the result of mineralizers more active than those accompanying the sub-silicic rocks.

(27) There is a parallelism between the various groups of high-temperature deposits, of which the magmatic ores are one division. In all groups, high-temperature silicates precede the introduction of the ore, and hydrothermal stages follow. In contrast with the magmatic deposits, the non-magmatic ores are characterized by a complex set of pre-mineral silicates, and the hydrothermal stage is generally the most important period of ore introduction.

(28) The temperature at which the introduction of ore-minerals is initiated is about the same for all the high-temperature deposits; probably not higher than 300-400° C.

(29) Gradations between the typical magmatic ores and other high-temperature deposits are shown by the local development of garnet and tourmaline. Further, the gradations of these into intermediate-temperature and low-temperature deposits is strong evidence of the magmatic origin of ore deposits in general.

(30) The following orderly series of events is recognized in magmatic deposits:

(a) Crystallization of primary silicates;

(b) The development of hornblende and biotite, and occasionally tourmaline and garnet, as magmatic-alteration products;

(c) The introduction of the ore-minerals;

(d) A small amount of re-arrangement of the ores and the development of secondary silicates by hydrothermal solutions.

Canadian Mining Regulations

The Governor-General-in-Council has issued an order affecting mines during the existing War, the essentials of which are as follows:

1. No assignment of any right in waters, lands (mining or other) may be permitted except to persons who were at the beginning of the War subjects of Great Britain or citizens of the Allied Powers.

2. In case of transfers of this nature through error or fraud, they shall be void and any fees paid shall be forfeit.

3. No company other than those of Great Britain or Canada may acquire or hold any such rights. The restriction extends to companies controlled directly or indirectly by foreigners.

4. No changes may be made in the articles of association, constitution, or by-laws of any company without consent of the Minister of the Interior. Infraction of this regulation will result in declaring the company to have ceased to be a British company, and in forfeiture of its rights, powers, and benefits.

5. Prescribes the procedure for cancellation of the company's rights by the Minister of the Interior.

6. Provided always that where any entry was granted for Dominion lands, or where any grant of any right, power, or benefit hereinbefore referred to was made before the passing of the order in council of the 14th day of December, 1916 (P. C. No. 2614), to a person who, after the passing of the said order in council, would have been debarred from making entries or acquiring such right, power, or benefit, a patent may be issued in the case of Dominion lands, and a lease, license, or certificate, as the case may be, may be granted for such right, power, or benefit in ordinary course upon proof being submitted in each case that the conditions requisite for the granting of such patent, lease, license, or certificate, as the case may be, have been fulfilled and performed, and, in the case of Dominion lands, upon evidence being also furnished satisfactory to the Minister of the Interior that the holder of the entry is a British subject.

IRON ORE to the extent of 200,000,000 tons has been estimated by geologists and engineers to be available in Canada, the greater part of which, however, is low-grade. The annual production of iron ore in Canada is about 400,000 tons, and its present blast-furnace capacity is 1,500,000 tons yearly, though the actual output of the Canadian iron-furnaces is about 1,000,000 tons. About 75% of all the iron and steel, and iron ore as well, required in Canada is imported.

The Nature of Chromic-Iron Deposits

By SAMUEL H. DOLBEAR

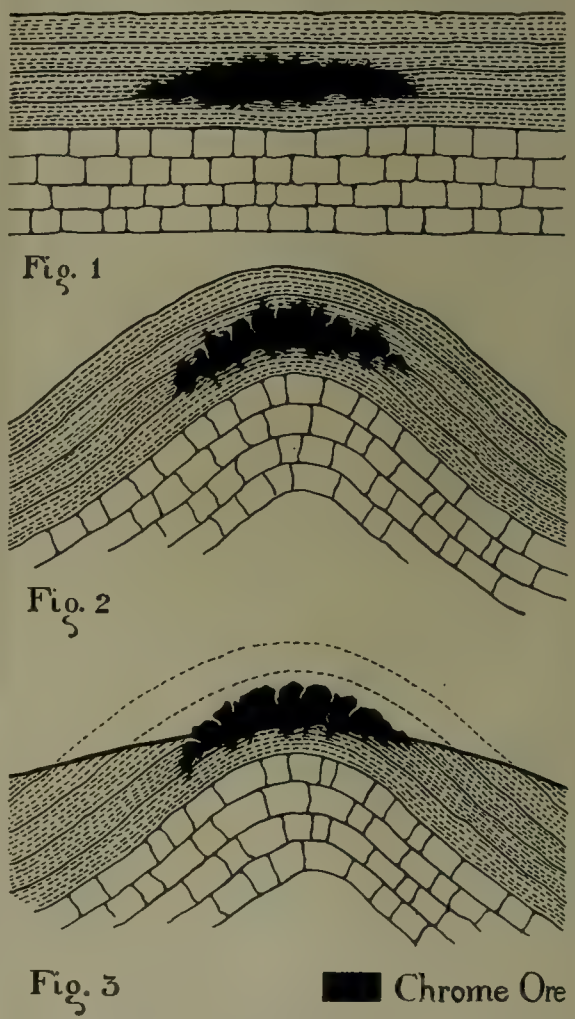
The following paragraphs are written with the hope that they may help the miner of this mineral to understand the nature and occurrence of such deposits. Fortified with this information he may better judge the advisability of prospecting certain areas, and furthermore there will be less likelihood of over-estimating the quantity of ore when only outcrops and other superficial evidence are visible.

It seems remarkable that so few miners of chrome ore understand the character of the deposits. I think that in most cases the miner considers he is opening an orebody occurring in more or less irregular veins, and that the origin of the ore is similar to that of quartz veins. Outcrops may be found for a distance of several hundred feet, and in such alignment as to give the impression that the deposits are continuous. The handy pencil is then put to work to calculate that the average width of the orebody is, say, 11 ft., the 'vein' can be traced for 800 ft., and the ore ought to persist at least 20 ft. below the surface, giving, therefore, a total of 176,000 cu. ft.; which, at 10 cu. ft. to the ton, makes 17,600 tons of ore. This amount is then offered for sale.

So many estimates of tonnage based on such false hypothesis have been submitted to me, that I have had to establish the safety-first rule of catechizing each miner. His conception of the origin of chrome deposits determines, in a large measure, the accuracy of his estimate. This misunderstanding is not confined to miners alone; I have on file many reports made by those who choose to call themselves engineers, in which the same error is made. In one which was recently sent me the writer of the report became enthusiastic because "the formation had been broken by movement of the rocks thereby creating large channels through which the groundwaters could circulate, depositing chrome ore on their walls!"

ORIGIN OF CHROME DEPOSITS. To understand why estimates of chrome cannot be prepared in the above manner, it is necessary to know something about its origin.

When two substances, one of which is more soluble than the other, are dissolved in water, and the water is then evaporated, the least soluble substance will crystallize out first. During the period when the earth's crust was forming, chrome was in solution, not in water, but in the molten magma which formed rock on cooling. Chrome being more insoluble than other substances present, was one of the first materials to crystallize from the magmatic solution. During this crystallization, the particles aggregated in irregular masses due to a force known in nature as cohesion. When the cooling process was complete, and the entire mass was solidified, these irregular bodies, which are designated lenses, were probably near the bottom of the formation in which they are found. As the weight of chrome ore is much greater than that of the rocks in which it occurs, it seems probable that it settled near the bottom during its aggregation. If this is to be accepted as correct, the question arises, "How did it reach the surface?" Folding, faulting, and weathering are the forces responsible for its exposure to the surface.



In Fig. 1 the lens of ore is shown in its normal position on cooling; later folding resulted in the mass assuming the position shown in Fig. 2; dynamic agencies, including erosion, resulted in conditions such as appear in Fig. 3. The dotted lines indicate the former position of

the rocks that concealed the deposit as shown in Fig. 1 and 2. The dark portion represents the consolidated mass of ore, surrounded by smaller bodies and segregated particles, which, attracted toward the main orebody, have not reached it because the progress is impeded by gradual solidification of the magma into solid rock.

All chrome miners are familiar with the gradual increase in the amount of waste-rock in their ore as the limits of their deposits are reached. Occasionally a deposit is found in which the line between the ore and wall-rock is distinct, sometimes separated by 'gouge' or 'miner's talc.' When no chrome ore is found in the wall-rock immediately adjoining the orebody, and gouge is present, it may indicate that the original wall-rock has been removed by displacement. The ore along the wall may be fluted or grooved, and if the disturbance has been sufficient, the orebody may be coarsely fractured, or even so finely crushed as to make it friable in the hand. Otherwise, if no chrome is present in the wall-rock, it may be due to earlier genetic causes. Some magmas were undoubtedly more fluid than others, just as some smelter slags run freely while others are so sluggish that they freeze readily at the tuyeres. In a particularly fluid magma there would be flow-currents just as there are in water, these tending to carry away chromite particles which had not yet consolidated with the main chrome mass. For this reason I conclude that the largest chrome deposits were probably formed in magmas relatively free from flow currents.

CHROME ORE IN MAGNESITE

VAUGHN CHROME OUTCROP

Chrome ore, when found, is always present in basic-igneous rocks, such as peridotite or its altered form, serpentine. This is probably due to the fact that chromium is more soluble in basic than in acid magmas.

Distribution of Chrome in Chrome Deposits. All parts of chrome deposits are not of equal grade. The question has been asked, "What may be expected to be the highest grade?" In most deposits the ore near the walls or bottom is less pure than that in the main ore-mass. In the latter, however, there is much variation; and there is no rule to follow concerning its chrome-content. This irregularity is probably due to minor influences during the period of formation. The principal impurity is not necessarily silica; it may be iron, magnesia, or alumina. If iron be present as magnetite, the ore may be heavy and black, and appear to the eye to be high-grade, yet be low in chromic oxide. Some good ore is found with a film of magnesium carbonate, so that it is white in appearance, and such ore has been condemned because, for that reason, it was considered to contain too much silica. It is important to remember this: "you cannot make an optical analysis of chrome ore."

Field Determination of Chromite. Familiarize yourself with the appearance of typical chrome ore. Scratch a piece of the suspected ore with a knife, deep enough to penetrate any surface film of foreign material. If the streak is dark-brown, the material may be chrome.

If the prospector will provide himself with a spirit lamp, two inches of platinum wire (fixed in a short glass tube) and an ounce of borax, he can make a fair determination. The operation is as follows: Crush a small piece of the ore with pestle and mortar. Bend a small loop at the end of the platinum wire. Heat the wire a moment in the flame, and dip in the borax. Some borax will stick to the loop. Melt this in the flame and continue dipping in the powdered borax and melting until

the loop has become filled with a bead of colorless borax-glass. Heat the bead to redness, and while hot place it against the crushed ore until a few particles adhere to the bead. Hold this in the flame until the particles are entirely dissolved in the borax and allow to cool, when the bead, if chrome is present, will have a bright green color. Having determined that chromium is present, send the sample to a reputable chemist and ask him to determine chromic oxide and silica. The ore-buyer must know the percentages of these two materials before he goes further.

MARKETABLE ORE. To be readily salable chrome ore should contain at least 40% chromic oxide (Cr_2O_3) and not less than 8% silica (SiO_2). Some ore is sold which carries not more than 30% Cr_2O_3; sometimes SiO_2 as high as 10 to 15% is permitted. Ore containing 40% Cr_2O_3 is more satisfactory in fire-brick manufacture than 30 or 50% ore. When other grades are purchased they are sometimes crushed and mixed with higher or lower grades, as may be required, to secure a 40% product.

Chilean Smelter to Handle Bolivian Tin

A stock company under the name of Compañia Chilena de Fundición de Estaño (Chilean Tin Smelting Co.) has been organized with a paid-up capital of $243,000 for the purpose of establishing a smelter in the port of Arica, Chile, to treat tin concentrates from Bolivia. The committee of engineers having charge of the installation of this smelter is composed of Guillermo Yunge, Durward Copeland, and Richard Gabler. Tin ingots 99.75% fine will be made. It is said that the plans include the treatment not only of tin concentrate but of other minerals, and the ultimate installation of a manufacturing plant. The work is being done for the owners of the Llallagua Tin Co., Sr. Gigliotto, manager, Santiago, Chile. The capital is Chilean. The mines are at Llallagua, Bolivia, and form one of the two largest groups of tin mines in that country, the other large one being Patino. Durward Copeland, one of the engineers, is an American, formerly professor of metallurgy at the Missouri School of Mines. He has traveled in Cornwall, China, Straits Settlements, and Bolivia, gathering data. He is now at Arica, Chile. Construction has been started, the Chilean government assisting the company with grants of land and water rights.

TRINITROTOLUOL and picric acid explosives can be manufactured at a cost about 40% less than nitroglycerine. From this circumstance J. R. Mardick, writing in *Metallurgical and Chemical Engineering*, points out the probability that the manufacturers of these nitro-aromatic explosives will dominate the market for blasting compounds after the War. This would cheapen mining operations. The enormous increase in by-product coking since 1914 renders this assumption highly probable, since the raw materials for 'T.N.T.' and picric acid are derived from that process.

Aid to the National Cause

By courtesy of the Utah Metal & Tunnel Company, we have received a copy of a telegram sent to Beer, Sondheimer & Co., in response to an invitation from the latter (who are the Utah company's metal-selling agents in New York) to meet Mr. Bernard Baruch with reference to the selling of their product to the Government.

Boston, April 5, 1917.

Messrs. Beer, Sondheimer & Co.,
61 Broadway, New York.

Dear Sirs—

We confirm to you our telegram of April 5, 1917, as follows: "We do not like the appearance of dealing with our national government through an intermediary. To us it is amazing that the copper producers of this country are so blind to their own interests and that of their stockholders as to make an offer of sale to the Government that permits them to exist. We read in the newspapers that the copper producers of the country have agreed to sell their own Government about 3% of their annual production for 16¾ cents per pound. We expect soon to hear that our soldier-boys will be offering their blood at about this price per quart. We therefore make this proposition: That we will give to the national government 3% of our copper product for this year and a larger percentage if a substantial proportion of the copper producers of the country will agree to the same terms and that we will likewise give to the national government a like percentage of our lead product, provided a substantial proportion of the lead producers of the country will join, without any price; and if the lead and copper producers of the country see fit to enlarge this percentage as a gift to the Government we will gladly join with them in increasing the proportion of our offer. We will comply with this proposition upon the request of the War or Navy department. We feel that this is an excellent opportunity for the corporations of this country to give the lie to the slanders which they have been under for many years, and we have not that faith in men that we can clearly discern how much short selling of copper stocks will be based on this thimble-rigging of mining companies by people who are willing to snuff the battle afar off provided they can short the stock market."

Very truly yours,
UTAH METAL & TUNNEL COMPANY,
(Signed) WILLIAM E. L. DILLAWAY,
Secretary.

EXPLOSIVES for blasting rock ahead of a steam-shovel when the ground is wet should preferably be a low-freezing gelatin from 40 to 60% strength. Existing prices of glycerine being high, contractors find that good results can be obtained by using lower-grade explosives where higher grades were formerly thought necessary. If the work is dry a low-freezing dynamite can be used. In tight, hard bottom gelatin is best because, in addition to the advantage of not needing to be thawed, it combines density with high water-resisting power. Density is an advantage in that more weight of explosive can be concentrated in the bottom of a bore-hole of any given diameter than when lighter grades of dynamite are used. For sub-aqueous rock-blasting, a 75% strength gelatin-dynamite is best adapted. Nothing weaker than a No. 8 electric blasting-cap should be used with any gelatin. There is enormous potential energy in gelatin-dynamite, and in order to release it a No. 8 detonator is necessary.

Vanadium for Aeroplanes

Vanadium has been in great demand since the outbreak of the War for the steel parts of aeroplanes, submarines, and in armor plate for warships and armored motor-trucks. Light machine-guns and aerial artillery are almost wholly constructed of vanadium steel. In all cases where it is essential to reduce weight without sacrifice of strength, and especially where great resistance to shock is required, this alloy is employed. The growth of the vanadium industry has been phenomenal. In 1905 only 1000 tons of vanadium steel was produced. This was used for high-speed tool-steel. The present consumption of ferro-vanadium, which is used in the manufacture of the steel-alloy, is nearly 1000 tons per month, representing about 8000 tons of steel. The objections offered to the use of vanadium were essentially the same as those that now operate against molybdenum; it occurred in deposits that were not dependable. No assured supply was available, sufficient to sustain a growing market. The discovery of the famous vanadium sulphide (patronite) deposits in Peru in 1905 was the basis on which the industry grew. The mines are at an altitude of 16,300 ft., at Mina Ragna, 32 miles from Cerro de Pasco. The ore yields 19% vanadium, and an enormous tonnage has been developed. Its reduction is accomplished by an electric process, the details of which are not made public. Refining is done by other means, but the bulk of the world's vanadium is produced by methods largely perfected by D. Saklatwalla, chief metallurgist of the American Vanadium Co., at Bridgeville, Pennsylvania. This concern was developed from small beginnings about 25 years ago, when James Flannery, a Pittsburg undertaker, was compelled to take over the infant industry with the patents on which it was based, to cover a loan. This accident has made him a millionaire. At the beginning of the War the stock of the company was quoted at $152 per share. Recently the controlling interest was acquired by a syndicate headed by J. L. Replogle, president of the Cambria Steel Co., at $1000 per share.

Laurium and Preparedness

The silver mines of Laurium in Greece had been operated for many centuries with varying fortunes. In the time of Themistocles, in the fifth century B.C., the production of silver from these mines had fallen to nearly nothing. By his order the region was examined by a commission, on which the elder Xenophon was the leading spirit. As a result the mines were nationalized and a leasing system under rigid requirements as to continuous operation, was established. The State exercised close surveillance over the work, and facilitated the treatment of the ores and the refining of the output. This systematic effort led to such an enormous yield of silver that the profits excited the cupidity of the Athenians. A proposal was made by the chief men of the Athenian oligarchy to divide the proceeds among the citizens. This was partly stimulated by political antagonisms, intended to weaken the authority of Themistocles and to add to the strength of his opponent, Aristides. Themistocles, however, realizing the peril of an invasion by the Persians, succeeded in overcoming the popular clamor and secured a vote in favor of utilizing the profits from the Laurium mines in the construction of a great navy for national defense. His foresight saved not only Athens but all Europe from the Asiatic foe. Xerxes bridged the Hellespont, crossed Thrace, Macedonia, and Thessaly, but was defeated at Salamis with the aid of the Athenian fleet in 480 B.C.

Electric Activity in Ore Deposits

It is well known that many chemical reactions are capable of developing measurable electric currents, and it should be expected that in places where chemical action is in progress in ore deposits today electric activity should be detectable. This has been shown to be the case by several experimenters. In Bulletin 548 of the U. S. Geological Survey, entitled 'Electric Activity in Ore Deposits,' Roger C. Wells records a series of measurements of electric potentials developed when various metallic minerals common in ore deposits are in contact with water or with solutions of various salts. Mr. Wells concludes that the character of the solutions has fully as great an influence on the electric activity developed as the nature of the metallic minerals, and that in general acid and oxidizing solutions give the highest potentials, and alkaline and reducing solutions the lowest. Economic geologists have long recognized that the solutions in the upper oxidized portions of many ore deposits are acid and oxidizing, while farther down they become neutral or alkaline. Whether such variations and the electric differences dependent upon them are sufficient to cause an appreciable electric current to flow from the upper part of an ore deposit to a lower part or vice versa is still an open question. Such action, if it exists, is of relatively minor importance in controlling ore depostion, the main factor being the actual movement of metal-bearing solutions from one place to another. Measurements of electric potential can, however, be easily made and may prove useful in indicating the direction and intensity of the chemical reactions of which they are one expression.

Laboratory equipment for testing rare-metal ores in quantities from 10 to 500 lb. has been installed at the technologic department of the Bureau of Mines at Golden, Colorado. The plant includes apparatus for making acid, alkaline, or saline leaches, as well as fusion-tests. A small wedge furnace and a tube-furnace affords facilities for roasting tests.

Stetefeldt, a metallurgist of wide experience, made the claim that amalgamation can be better accomplished in an arrastra than in an iron amlagamating-pan, the presence of the iron, he says, is detrimental to the best results in pan-amalgamation.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

PLATTEVILLE, WISCONSIN

SNOW AND BAD WEATHER HANDICAPS PRODUCTION.—HIGH PRICES MAINTAINED ALMOST TO THE END OF MARCH.—NEW MILLING PLANT GOING IN.

A disastrous sleet storm, which swept the entire Wisconsin zinc-bearing area, March 13, wrought considerable damage to the mining industry and associated interests. Roads were entirely obliterated, telegraph and telephone-lines were seriously injured, and power-lines were crippled. The tie-up on railroad lines extended over a period of several days and it was two weeks before the mining industry regained a normal condition. The storm could not have come at a more inopportune time. Prices for both zinc ore and lead ore, consistently high, had prevailed uniformly over a stretch of weeks and the more prominent zinc-producing groups were engaged in splendid profit-taking. Production was given a decided set-back and ore-deliveries were impeded to such an extent that whole districts failed to make their usual weekly reports. The incentive to 'make hay while the sun is shining' found operators working all over the field at maximum capacity until the break due to the elements came; then, many producers showed a decided curtailment in both output and delivery. As quickly as possible the damage was repaired but the showing expected under the favorable conditions prevailing at the beginning of the month failed to materialize and the complete returns for the field for the entire month were disappointing.

Prices for zinc ore uniformly high and constant all month found the base at the beginning of the month at $90 per ton for premium-grade with the range down to $85 on medium-grades. Refiners and producers shipping to smelter direct under contract agreements seemed to possess the advantage.

Aside from the market offered by the New Jersey Zinc Co. there was little or no open-market buying of low-grade ore in the field during the month. More and more there is coming into evidence a well-defined policy to circumvent this practice of the zinc-ore producing industry. The smelters represented in the field, and that are engaged in mining as well, have their local refineries and ship direct. Other large operating groups have their refineries and sell to the smelters under contract, while a few companies of prominence are selling mine-run product to smelters, and shipping the various grades of ore as they come from the jigs, also under flat-rate agreements. From this statement of facts it is evident that in a short time there will be little if any open-market selling. The competition which developed in the field recently between controlling smelter interests now is being reflected in a determined effort to conserve individual interests. New buying interests have to a large extent supplanted the older established outlets for Wisconsin zinc ore. The American Zinc Co. of Hillsboro, Illinois, not heretofore very active in the buying of high-grade ore, is fortified with the output of associated groups of mines in addition to the product secured through purchase. In matter of tonnage, thus obtained, it held strong, securing during March 79 cars—3119 tons. The Grasselli Chemical Co., of Cleveland, up to about a year ago regarded as no formidable contender for buying honors, through keen foresight, quietly, but aggressively, engineered a program of buying under contract agreement and how well this company succeeded is learned through last month's buying when 69 cars went to the Cleveland concern for a total of 2546 tons. The plans of the New Jersey Zinc Co., far-sighted indeed, were adopted years back and include the operation of mines owned in fee by that syndicate as well as refining-plants on the ground, where local production is treated as well as the ores secured in open-market buying from the small independent producers. This combination, although expressed for the Wisconsin field only, explains why the New Jersey Zinc Co. has been able during the past few years to pay its famous dividends, and also why they will be continued. There was received at the reduction-plants of the Mineral Point Zinc Works, during March, 193 cars of mine-run ore aggregating 7378 tons, from which was extracted and shipped to smelter at DePue, 3461 tons of high-grade separator-blende. Other buyers of high-grade ore during March were the Edgar Zinc Co. which received 20 cars (753 tons) from the Oliver Mining Co. at Shullsburg; the Matthiesen & Hegeler Zinc Co. at La Salle, 19 cars (771 tons); the Illinois Zinc Co. at Peru, Illinois, 14 cars (556 tons); the American Metal Co., 7 cars (252 tons); the Eagle-Picher Lead Co., 5 cars (187 tons); and the Lan-Yon Zinc Co., 3 cars (132 tons). From all of the foregoing it is no difficult matter to infer which of the smelting interests is now in control in the Wisconsin field, and it is a fair criterion of what is taking place in other fields as well. The ancient and honorable peace, so long maintained between the leading smelter interests, it appears, has been destroyed and it is now a case of 'each for himself and devil take the hindmost.' That the conflict has inured to the advantage of the zinc-ore miner can be attested by the further fact that prices in the Wisconsin field for zinc ore for the month of March showed an unmistakable advantage over the quotations obtaining in the Missouri zinc districts, for the entire month. Had the weather remained fairly good, and had the field been spared the experience of the destructive sleet-storm above referred to, the month just closed would have been one of the most profitable in the history of the field. The conflict is by no means ended. Struggle for mastery must remain an interesting feature of the industry for some time to come.

Not until well toward the close of the month did there come any intimation of a break in prices and then a weakening metal-market precipitated a decline of $5 per ton, the base receding to $85 for premium-blende with the range down to $80. Even at these figures advantage remained with the Wisconsin zinc-ore producers, since Joplin quotations for the same period had a wider latitude, the range running from $70 to $85.

Lead-ore producers in the Wisconsin field unloaded a small portion of their holdings in the early days of the month at the high prices then prevaling—about $122.50 per ton. The metal-market showed no tendency to deteriorate, yet, in spite of this, a break came; the price dropping to $115 per ton, base of 80% metal content. Production showed nothing of a surprising nature, but fair weather it is claimed by the experienced ones, will encourage miners to invade shallow diggings and rig-up open-wash places, when an increased output is expected.

While the demand for pyrite remained good and prices were fairly high no disposition was shown to market ore in quantity. The high prices for zinc ore, a scarcity of cars due to bad weather, and a determination to get all the zinc ore to market possible, were factors mainly responsible for the poor showing made in deliveries during March.

Producers of carbonate zinc ore, operating in the northern districts of the field, met serious drawbacks in the inclement

weather and correspondingly bad roads. The quotations offered were standard and steady, going from $40 to $60 per ton, base of 40% zinc content, but production was light and shipments restricted.

Much prospect work was carried through successfully during March and a number of new producers were ushered into active existence at several points in the field.

Deliveries of ore, for March, were reported by districts as follows:

Districts	Zinc, lb.	Lead, lb.	Pyrite, lb.
Benton	23,404,000	148,000	.....
Mifflin	6,994,000	166,000	.....
Linden	3,954,000	62,000	160,000
Cuba City	3,678,000	.....	2,906,000
Galena	2,438,000	82,000	.....
Hazel Green	2,422,000	.....	.....
Shullsburg	2,334,000	182,000	.....
Platteville	2,178,000	132,000	.....
Potosi	1,040,000	48,000	.....
Highland	946,000	.....	.....
Montfort	176,000	60,000	.....
Dodgeville	110,000	.....	.....
Mineral Point	56,000	.....	1,126,000
Total	49,730,000	880,000	4,192,000

The gross recovery of crude concentrate aggregated 21,000 tons, net deliveries to smelter, including both refinery-ore shipped from separating-plants and mine-run direct, 12,333 tons. The Mineral Point Zinc Co. going with two reduction-plants, had an exceptionally good month after overhauling the plants, shipping nearly 7,000,000 lb. of top-grade blende to smelters at DePue.

Summarizing briefly, the more important developments in the field for March were as follows: In the Highland district, the New Jersey Zinc Co., after a determined search for water-supply for milling, lasting more than a year, was rewarded with an ample flow from a well 500 ft. deep, and a force of 60 men secured employment in a new mill finished a year ago. A demand for increased pay and shorter hours in the Montfort district resulted in a walkout and the discharge of the entire working-force at the O. P. David mine. Dodgeville welcomed a new producer to be known as the North Survey Mining Co. A contract for a 100-ton mill has been awarded to Charles Singer, the general manager for the Optimo & Linden Zinc Company. The M. & A. Mining Co. at Mifflin, after a successful run, has paid 40% in dividends. Double-shift became the order and heavy deposits were found in the mine-floor. The phenomenal showing made by the Block-House Zinc Co., at Platteville, resulted in the payment of $60,000 in diivdends, during the month on a capitalization of $24,000, addiitonal leaseholds were proved with drill prospecting, which will extend the life of the mine. Several new producers were brought to the shipping stage in the Cuba district. Benton made big gains in new developments and exerted itself in hard-road building. Five new power and mining-plants are to be built in this district. A branch of the Northwestern railway is being constructed to New Diggings, in the interest of the miners. The Mulcahy mine at Shullsburg, a new producer, showed up well and reaped rich dividends. The Birkbeck mine, a new find only recently developed and equipped in the Galena district, was abandoned. Potosi offered a new producer in the Tiffany mine, which settled down to a shipping basis, in keeping with the program followed by the old regulars. The Galena-Joplin Separators operated for years with success suspended operations and the ores usually treated there will be diverted to the big Skinner separating-plant, at New Diggings.

LATOUCHE, ALASKA

CONSTRUCTION WORK ADVANCING RAPIDLY, AND PART OF THE NEW MILL IS IN OPERATION.—A WELL-APPOINTED CLUBHOUSE.

Rapid progress is being made in construction work in spite of the heavy snow-fall and the inclement weather generally. An addition to the power-house, an addition to the hospital, several new cottages, a hoist-house, and a compressor-building are under construction.

The addition to the power-house will accommodate two Diesel engines of 500 hp. each. At present 1000 hp. is supplied by steam-turbines.

The hoist-house will contain the engine that will hoist the ore from the haulage-drift that connects the mine with the mill; the ore will be dumped from the skips directly into bins in the new-crushing plant.

Two out of four of the proposed units of the new mill are in operation. The mill is equipped with Marcy ball-mills, Hardinge pebble-mills, flotation-machines, and Oliver filters. Each unit of the new mill can handle 500 tons per day. The new crushing-plant will be equipped with gyratories and Symond disc-crushers.

LATOUCHE, ALASKA

Three motors have arrived that will haul ore from the mine to the mill, horses being used for that purpose at present. The motors are 5-ton Westinghouse, and are equipped with storage-batteries.

About 350 men are employed here. E. T. Stannard is manager, and K. C. Stadtmueller is assistant manager.

The Latouche Club, with an initial membership of 45, has recently been formed and will formally open the new club-rooms with a big 'smoker' in the near future. The club-rooms contain bowling-alleys, pool and billiard-tables, a reading-room, and a library.

SUTTER CREEK, CALIFORNIA

KENNEDY MILL HANGING-UP STAMPS.—NEW ARGONAUT MILL NEARING COMPLETION.—CELEBRATION AT SUTTER CREEK.

Sinking is in progress at the Hardenburg mine, at Middle Bar, on the Mokelumne river, the intention being to put the shaft down an additional 300 ft. In this sinking, the vein will be crossed, the shaft being vertical, and levels will be run

below the intersection to prospect thoroughly the vein. W. J. Loring, whose company is reopening this mine, has spent the past week in Amador county.

At the Kennedy mine 40 stamps of the 100-stamp mill were hung up during the week, partly for repairs, but mostly as a result of a shortage of rock. The wages paid at the Kennedy mine are said to be lower than the rates prevailing at the other mines of the county and the company finds it more difficult to get miners. It is reported that the Argonaut Mining Co., whose property adjoins the Kennedy mine, raised the wage scale 25c. a day recently, so as to retain the full working force.

Twenty stamps will soon be dropping at the new mill of the Argonaut, which was recently erected on the hill west of the shaft. The 40 stamps now in operation at the old mill also will be removed shortly to the new mill, to work in conjunction with the heavier batteries with which the new plant is equipped. During the process of moving, the intention is to keep 40 stamps in operation, only 20 of the old stamps being moved at a time.

W. E. Darrow's new plant for handling the tailing from this up-to-date mill is in course of construction between the mill and the large Eastwood dam and will be completed by the time the mill begins crushing.

The Crown Point quartz claim, near Drytown, has been bonded by Mrs. M. E. Fontenrose, of Jackson, to G. C. Dickerson for a consideration of $7000, of which $5000 is payable on or before October 1, 1917, and $2000 on or before April 1, 1918.

Sutter Creek already presents a gala appearance in preparation for the Mother Lode carnival to be held here on Saturday, April 14. Flags, bunting, evergreen, and incandescent-lamps have transformed the appearance of the principal streets. An immense arch has been erected across Main street, under which will march the parade with characteristic features commemorative of pioneer days, and illustrating the progress since made in the mining industry. The forenoon's exercises, consisting of music, speeches, a drilling-contest, and first-aid work, will be held at the old Eureka ground. Three brass-bands have been engaged for the day in addition to the dance-orchestras. In the afternoon will be held a track-meet at the high-school, in which various schools will compete; also a baseball-game between the star teams of the county. Several dances will be given, one at Levaggi's hall, during the entire afternoon and evening, and one at each of the local garages during the evening. A tug-of-war is scheduled for the evening on Main street, as well as a band-concert and a confetti-carnival. The carnival has been arranged as a fitting expression of the satisfaction of the people in the renewed mining prosperity, and particularly in honor of the re-opening of such old producers as the Old Eureka and the Plymouth Consolidated mines, and the extension of mining operations at several other important mines.

AFRICA

The management of the Ashanti Goldfields Corporation (Ltd.), reports by cable that the returns for February were as follows: 8829 short tons was crushed, yielding 9508 oz. of fine gold, having an estimated value of £40,322.

The results for January were:

Value of output		£40,280
Working costs in West Africa and general expenses in London		17,180
		£23,100
Government royalty, 5% on output	£2,014	
Total cost of mines development	4,076	
Depreciation on plant, machinery, etc.	1,820	£ 7,910
Estimated profit		£15,190

ELY, NEVADA

LARGE SCALE OPERATIONS AT THE RUTH MINE.—ARRANGEMENTS TO FACILITATE AND INCREASE OUTPUT.—THE LINCOLN HIGHWAY.

The Nevada Consolidated Co. is running full blast, putting through the mill, close to 13,000 tons daily; of this, over 3000 tons is coming from the underground mining operations in the Ruth mine.

The Star Pointer shaft (working shaft of the Ruth) has been deepened 200 ft. and driving is in progress at this level at both ends, 2100 ft. between the faces, to get in shape for extensive mining on this level, also to increase the tonnage from the Ruth. A new electric-hoist, of 5000 tons capacity, has been ordered, also more electric-locomotives for underground transportation. The company expects to handle 5000 tons daily from the Ruth, in the near future. At the concentrator at McGill construction work on the new crushing-plant is being crowded; owing to delays in receiving the machinery, it will be two months before this can be put in operation. It will increase the capacity 25 to 35%. By moving the assembling-yards, which are now near the steam-shovel pits, down to the flat near Keystone, and with dinky-engines delivering the cars there and taking the empties back, it is said that the present equipment of the Nevada Northern railroad, by adding automatic-dumping ore-cars to its equipment, will be able to handle the increased tonnage. Up to the present the facilities for ore transportation between mines and smelter have not been adequate and the changes mentioned have been contemplated for some time past.

The Consolidated Copper Mines Co. (old Giroux) mill 500-ton unit is running through 600 tons daily, and it is said that the results are satisfactory; this ore comes from the underground mining at the Morris shaft. The additional unit of 500 tons is being pushed to completion as fast as possible; but here also there are delays in the delivery of necessary materials. Captain Hogan, who was in charge of sinking what is known as the New Giroux shaft (on the Alpha side of the Giroux property) is back, in charge of operations on this shaft. From the tenth level he has been repairing and re-timbering the level out into the Alpha orebody. He has already extracted a few cars of ore. This ore is all carbonate in the oxidized zone; it is of good grade, and will stand shipment to the Salt Lake smelters at this time, owing to the high price of copper. There was a considerable tonnage blocked out here before the Alpha shaft was lost. The water-level in the New Giroux shaft for a long time has stood a little below the tenth level. Water is obtained by pumping from this shaft for milling purposes; but it has only lowered the water in the shaft about 35 ft. The electrical pumping-plant on the twelfth level has been drowned for the past two years. It is said that extensive drilling-operations will be commenced on the Giroux in the near future. It is generally understood that this property now is controlled by Humphreys, Merritt, and Burgess, who, it is said, have recently financed the operations. Lessees throughout the county are not yet shipping much ore, owing to the condition of the roads.

The county commissioners of White Pine county are advertising for bids to change the road up Robinson canyon between Ely and the mines. The canyon is narrow and it is occupied by both the railroad and the wagon-road; it is also a part of the Lincoln highway across the continent that eventually will be made a military road. This road is the most traveled of any road in the county. There are 13 grade-crossings, some of them dangerous. The proposed change will cost $20,000, but as the Nevada Consolidated Co. pays 84% of the taxes of the county, and are anxious for it, the Nevada railroad will move its tracks without cost to conform to the changes. This much needed improvement will be made now, while the county is prosperous. The change will eliminate all but three of the crossings.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

(Special Correspondence.)—Robbers recently stole a $20,000 gold brick from the Chichagoff mine, on Chichagoff island. Suspected men were arrested and have been brought to Juneau for trial.——The change-house at the Treadwell shaft of the Alaska Treadwell Gold Mining Co., was destroyed by fire on March 13.——The first unit of the Alaska Juneau 8000-ton mill was placed in operation on April 1. The start was made without a hitch. The remainder of the mill will be placed in operation as soon as completed.——D. McLennan and Colin Brown, construction foremen, who have been associated with the Bradley, Bruff & Labarthe Co. in building the Alaska Juneau mill, will leave for Burma, upon completion of their work here.

Juneau, April 4.

The Jualin mine, at Jualin, is producing $20,000 monthly. C. G. Titus is superintendent.

The March output of the Alaska Gold company was 217,700 tons, that averaged $1.09 per ton, 26 cents lower than the average during February.

General manager Thane explains that the management last month decided to treat the large amount of low-grade ore that was broken in the stopes. If the company decides to clean up the rest of this low-grade ore, the probabilities are that the assay value for the next month or two will not vary much from the March average. There is, however, considerable ore of better grade that will later become available for milling. When this reaches the mill the assay value should show a substantial increase.

The mill during March was operated on a 7000-ton daily average basis, or 1000 tons in excess of the original estimate of the company. Its actual capacity is nearly double that amount, or between 12,000 and 15,000 tons daily. The tailing losses in February were but 18.7c. per ton, the lowest in any month since the company started the issuance of monthly production figures. Since April last, when the ore assayed but 94c. per ton, the tailing losses invariably have increased a cent or two per ton.

ARIZONA

Cochise County

(Special Correspondence.)—An electrically driven pump has been placed on the 1800-ft. level of Junction shaft of the Calumet & Arizona Mining Co. to lift 1000 gal. of water per minute. The Junction shaft, when lined with concrete throughout its five compartments, from top to bottom, three years ago, was the deepest mine work of that kind attempted up to the time. The pump will be run by power from the company's smelter at Douglas, conveyed over a line just completed. In addition to the production of copper ore in this district, zinc-lead shipments are made to Kansas City, manganese is shipped to Chicago, and sulphuric acid is made from local sulphides, and goes principally to the New Cornelia Copper Co. at Ajo, where it is used in the recovery of the copper from carbonate ores. In addition the district is shipping fluxing-ores, mainly sulphides, to Sasco, Globe, and El Paso smelters.

Douglas, April 11.

Gila County

The Globe Commercial Copper Co. is shipping three cars of manganese ore weekly from its mines near Globe. A large body of 40% ore is said to have been opened. The ore goes to Temple, Pennsylvania.

Maricopa County

(Special Correspondence.)—The Superstition mining district, known in the early days as Goldfield, has awakened after a long period of idleness. The Goldfield Development Co., an organization of Salt River Valley business men, has sent to its property a 60-hp. oil-engine and air-compressor. Other equipment will be installed in the near future. The development plan has not been fully decided but will probably include a vertical two-compartment shaft, situated in the centre of an intrusive granite mass in which are many encouraging gold-bearing outcrops. The geological structure is complex, showing evidence of several periods of volcanic activity.

Ben Blackburn and associates are starting a new shaft upon their group of claims in another part of the district. They will continue sinking until water-level is reached. There are several other projects under way but these are as yet in the prospect stage, though promising.

Mesa, April 10.

Mohave County

(Special Correspondence.)—The United Eastern Mining Co. has purchased the Big Jim and Monarch claims from the Big Jim Gold Mining Co., paying therefor in treasury-stock at the rate of one share of United Eastern for six shares of Big Jim. The Big Jim has outstanding 750,000 shares of stock, requiring the payment of 158,333 shares of United Eastern. At the market, $4.80 the day of sale, this stock was worth $760,000, without considering the enhanced value through the acquisition of the Big Jim mine. United Eastern stock received in the deal will be delivered pro rata to Big Jim stockholders. A new company, the Big Jim Consolidated, has been organized to take over the Blue Bird mine, owned by the Big Jim Gold Mining Co., and stock in the new company will be issued to stockholders in the new company. The Blue Bird joins the United Eastern end-line on the north-west. It has a full equipment of machinery and a two-compartment shaft down 240 ft. The Big Jim Consolidated starts with a treasury fund of $20,000. United Eastern production in March was the highest since the mill started, when $150,091 in bullion was produced from 6584 tons of ore averaging $23 per ton. This is an increase of 1201 tons and $29,915 over February. Production since the mill started January 4, was $353,356 from 15,767 tons of ore. It is reported that the company will go on a monthly-dividend basis in July. Flotation-tests are being conducted on ores from the Gold Road mine at the concentrator of the United States Smelting & Refining Co., at Needles, California. A large tonnage of ore is being developed in the far east workings on the 100, 500, and 800-ft. levels. The mine is owned by the U. S. company and has a 300-ton cyanide mill. Sinking has been resumed in a winze from the 530-ft. level of the Gold Ore mine. The vein is five feet wide and shows free gold. The ore averaged $40 per ton for 33 ft., the depth of the winze. This company also is experimenting with flotation. It is near the Gold Road mine, on a parallel vein.

Oatman, April 11.

Recent development work in one of the upper adits of the McCracken mine in Cedar district, resulted in finding 2 ft. of high-grade lead-silver ore, and 6 ft. of concentrating ore, carrying 10 to 15% lead with silver. Work is also progressing on the lower level, and the rock broken, although low-grade, is promising and better ore is expected daily. In its early history the McCracken produced a great deal of rich ore that was shipped at high cost, but which returned large profit.

PIMA COUNTY

(Special Correspondence.)—John D. Cowan, of Salt Lake City, Utah, and associates, who own the Tucson-Arizona mines, situated 42 miles west of Tucson, Arizona, will expend about $100,000 in the purchase of machinery and equipment for the development of the property.

The New York-McAnneney Consolidated Mines Co., of which Mitt Quenner, of Los Angeles, California, is general manager, will install concentrating-machines and other equipment for operating dry placers at Greaterville, Arizona.

Tucson, April 12.

SANTA CRUZ COUNTY

(Special Correspondence.)—The Lower California Mining & Reduction Co. will erect a reverberatory-furnace as an addition to the concentrating-mill which it is now building at its mines three miles north of Nogales.

Nogales, April 11.

The shaft being sunk at the mine of the Arizona Consolidated Copper Co. at Mowry, reached the water-level about the first of the month and is still going down. The water is being bailed for the time being, but an increase in the inflow is anticipated and a pump will soon be required. Fred J. Miller is superintendent.

CALIFORNIA

The report of the State oil inspector for the week ended April 7, shows 16 new wells, making a total of 303 since the first of the year; 21 test of water shut-off; 15 deepening or re-drilling jobs, and 5 abandonments.

AMADOR COUNTY

It is reported that some recent development in the Oneida mine, owned by the South Eureka Mining Co., has been very satisfactory to the management. A large vein of good ore is said to have been developed in the lowest level of the Oneida, and the mill is running at full capacity. So abundant is the ore that plans are under consideration for the enlargement of the milling facilities.

Arrangements have been made for the treatment of a large tonnage of tailing from the Argonaut mill, near Jackson. W. E. Darrow and his associates will work the tailing by the Darrow method that for years has been successfully in use at the Bunker Hill mine near Amador City. Work on the Darrow plant has commenced.

BUTTE COUNTY

Frank Alexander, of San Francisco, has taken an option on 40 acres of land near Pentz grade, 12 miles from Oroville, for the purpose of working deposits of chrome. Work will begin at once.

INYO COUNTY

(Special Correspondence.)—The towns of Keeler and Darwin have experienced a revival of mining activity that promises to be permanent. The Cerro Gordo mine, 7 miles northeast of Keeler, about five years ago was not doing very well. Louis D. Gordon took a lease on it, and after expending thousands of dollars in overhauling the aerial-tramway, operated the mine profitably. When his lease expired October 1, 1915, the owners declined to renew it, but employed him as superintendent, and it continues to yield a handsome profit on its operations. Meanwhile, it is said, Mr. Gordon has secured a controlling interest in the property. The Darwin Development Co., an Eastern concern, also is making good at Darwin, about 20 miles south of Keeler. This company secured the Lane and Lucky Jim mines, and after putting in one unit of an oil-flotation plant and proving its efficiency in concentrating the silver-lead ore of that district, they have purchased the old-time Defiance mine, and the water-right at Coso, 8 miles south-west from Darwin, which furnishes the water-supply for the town of Darwin and the mines in the vicinity. They intend to add more units to their plant and bring the mine again into the list of profitable producers.

Keeler, April 12.

MARIPOSA COUNTY

The Mount Gaines mine, 6 miles east of Hornitos, is to be re-opened after a long idleness. It is reported that $50,000 will be spent in additional machinery, improvements, and development. The work is to be undertaken by Los Angeles people. W. J. McCray is manager. Electric hoists are to be installed. In the early days of the mine's career, steam-power was used, but later electricity was substituted, and the hoisting and drilling were done from the same unit—the compressor. By having separate units for the various branches of work, the mine is expected to be operated with greater economy. There are 12 men working at the property at present.

The Ruth Pierce mine near Hornitos is employing 25 men, who are working in three shifts. The mill is running and the output is satisfactory. James McMahon is manager.

NEVADA COUNTY

At the Allison Ranch mine, a few miles down the creek from Grass Valley, two large electrically driven pumps have been installed and the unwatering of the mine that has been idle for 17 years will soon be commenced. In its early history the Allison Ranch was one of the famously rich mines of this county, but the heavy influx of water resulted in closing it. When last in operation, about 1900, it was stated that the influx of water was 675 cu. ft. per minute. It is expected, however, that the modern pumps will handle the water without difficulty.

PLUMAS COUNTY

A discovery of a small vein of rich gold quartz has been made in the mine of the Plumas Basin Mines Co. The mine is in Granite basin. The new strike is on the 300-ft. level.

RIVERSIDE COUNTY

(Special Correspondence.)—Neil MacDonald, of New York, who owns a gold mine near Hemet, in the San Jacinto mountains, has ordered a No. 2 Denver quartz-mill, and other machinery equipment of the Denver Quartz Mill & Crusher Co. The ore is free-milling and will be treated by amalgamation. A. H. Cooper is superintendent.

Hemet, April 7.

SISKIYOU COUNTY

(Special Correspondence.)—The Dewey mine, also known as the Squaw Creek mine, is again in operation after an idleness of eight years. The mill is crushing 25 tons daily. Notwithstanding the fact that the workings were badly caved the new superintendent, Algernon Del Mar, has managed to pay expenses by drawing on ore already broken in the stopes. The primary cause for the shutting-down of the mine was inability to get fuel at a cost that was not prohibitive. The mine is now equipped with an electric-power line 8 miles long. The line is constructed of No. 6 galvanized-iron telephone-wire and carries 10,000 volts. It is intended to utilize 200 hp. The galvanized-iron wire, although not nearly so good a conductor of electricity as copper, is so much cheaper that it was considered good business to install it. The 8 miles of line did not cost over $5000 completed. The current is transformed to 440 volts, with separate motors for rock-breakers, stamps, and concentrators. It is intended later to re-grind the tailing and treat by flotation that which escapes from the Wilfleys.

Gazelle, April 5.

TRINITY COUNTY

The Schlomberg hydraulic mine on Coffee creek, owned by Stewart & Phillips, is to be operated this season. About $15,000 has been spent in equipment. The work will be in charge of Henry Carter.

TULARE COUNTY

(Special Correspondence.)—The largest rotary-kiln in use

in the world for the calcining of magnesite is being built by the Porterville Magnesite Co. at its plant three miles northeast of Porterville. It will be ready for operating the latter part of the month. The kiln is 125 ft. long, 7 ft. in diameter, and weighs between 50 and 60 tons. Five railroad flat-cars were necessary for its transportation from Allentown, Pennsylvania. It was originally intended for the burning of cement and was installed for that purpose at Santa Cruz, California, but never was used. It will be run by a 50-hp. electric-motor and will operate under a temperature of 2000°F., but as there is no other kiln of such great size in operation, its capacity can only be surmized; however, it is thought it can produce from 60 to 70 tons of calcined ore per day.. The Porterville Magnesite Co. is the largest operating company in this district. They have under lease 680 acres containing extensive deposits of magnesite of good quality. More than 300 men are employed, about 50 of whom work at the calcining-plant where a 50-ft. kiln has been in operation for some time, and which will continue to operate. The officers of this company are Walker W. Kamm, president; R. S. Edwards, vice-president; Philip S. Kamm, secretary-treasurer, all of San Francisco. F. F. Parker is local superintendent.

Porterville, April 12.

Yuba County

(Special Correspondence.)—With an option to purchase 1155 acres of the Ayer's estate across Bear river, 10 miles east of Lincoln, William B. Swears, of San Francisco, has secured what promises to be a valuable copper property.

Mr. Swears has known this property for many years, and 35 years ago sent samples to Denver for assays. At that time he was after the gold value in the ore, as the copper was then of little value. Many years ago the Ayer's estate, of Boston, bought 35,000 acres of land in the foothills of Yuba, Placer, and Nevada counties, and Mr. Swears on December 14, last, tied up the 1155 acres adjoining the Dairy Farm mine, owned by the Guggenheims. The property is two miles north of the Dairy Farm and one-half mile from the Guggenheim railroad, which carries the ore of the Dairy Farm mine to Sheridan. It is 10 miles by a good county road to Lincoln. The power line of the Pacific Gas & Electric Co. crosses the property and within 400 ft. of the main shafts. The principal showing of ore is in a shaft sunk close to Rock creek, but within a radius of one-half mile, nine shafts have been sunk or adits run, and in each the same clean massive sulphide ore has been found at water-level. Numerous assays of samples taken by engineers have returned from 5 to 9% copper, and $8 in gold and silver per ton.

The ore in place runs about 6 cu. ft. to the ton. Through the property run four dikes, that in which Rock Creek shaft is sunk, is a mineralized zone 5000 ft. long and 100 ft. wide.

Six hundred feet to the left of Rock creek is a gossan, 3000 ft. long and 75 to 100 ft. wide, carrying good value in gold. Extensive development has been commenced on the property, including a new shaft on the hill above the creek. Several of the old shafts are being re-opened, and a large force of men will be kept busy. Machinery and lumber have been ordered and houses are being built for the employees. Within 30 days shipments of ore to a smelter in Nevada will begin.

Lincoln, April 11.

COLORADO

Ouray County

The Mountain Top Mining Co. has recently completed an innovation in mining practice—a stamp-mill of 50 tons daily capacity, erected underground, 1000 ft. in from the portal of the adit, and 400 ft. vertically beneath the surface. Each department of the mill occupies a separate chamber cut in the solid rock, and these are connected by inclined raises. The Ouray *Plaindealer* thus described this unique installation: The mill has a capacity of 50 tons each 24 hours, and the equipment is as follows: Ore from the mine-cars is dumped into an automatic-dumping skip, is then hoisted 100 ft. and dumped into an ore-bin at the top of the mill, from which it passes over a grizzly to a rock-crusher, thence to the crushed-ore bin; subsequent treatment is by a ball-mill, worked in closed circuit with a Dorr simplex-classifier; roughing-tables, flotation, followed by flotation of both tailing and flotation-froth. Each of the several units is operated by a separate drive, there being altogether thirteen different motors used for that purpose. One advantage, at least, of this subterranean mill is that it will be absolutely free from disaster from snow-slides, no fire insurance is necessary, the temperature is uniform, and no fires are required.

The Gold Crown mill, just north of the town of Ouray, has been finished and has been making its trial run. The ore consists of quartz, calcium carbonate, and magnesian silicates through which is desseminated auriferous pyrite and chalcopyrite. The mill is modern and includes flotation-apparatus, partly of original design.

San Juan County

The Sunnyside mine, near Silverton, has been consolidated with the Gold Prince mine and will hereafter be known as the Sunnyside Mining & Milling Co. A 500-ton mill is to be built as soon as possible. The property is on the Mastodon vein. The Gold Prince mine was equipped with a mill, built at Animas Forks, which was connected with the mine by an aerial tramway over 12,000 ft. long. The mill or the process employed was not adapted to the ore and the property was closed-down. The new mill will be built at Eureka. The Sunnyside is said to have large bodies of zinc ore developed. The ore also carries gold and silver. Considerable ore was shipped last year. J. T. Terry is manager of the new consolidation.

MICHIGAN

Houghton County

The Calumet & Hecla mine is now hoisting and crushing about 10,660 tons of ore daily. It is expected to increase this tonnage when better weather prevails. The Osceola is producing to the full capacity of its milling facilities—4700 tons of ore daily. The output of the Mass mine is 1000 tons of ore per day.

NEVADA

Elko County

The recent prosperity of Jarbidge has resulted in a sudden and unexpected increase in the population of that camp, in consequence of which there is a shortage of food there. Although the merchants last fall laid in what was deemed a sufficient supply for the winter, they did not count on the favorable development of the district inducing what amounts to a stampede to the place. The strangers have drawn heavily on the food-supply. The high cost of living at Jarbidge is influenced by such incidental items as: Potatoes at $20 sack; sugar at $30 per 100 lb.; and hay at $100 per ton. The camp is at present practically snowbound and inaccessible, but the energetic miners and merchants will find a way to meet the actual necessities of the people.

Nye County

A discovery of rich gold ore in the granite in Shoshone canyon, two miles east of Round Mountain, is announced. It is near the tungsten mines discovered there a year ago. The gold is found in a small vein that has been opened for 20 ft. or more.

Storey County

(Special Correspondence.)—Not in more than 30 years has mining development been so active on the Comstock Lode as now. Not only is there greater activity, but indications are favorable to success elsewhere than in the stock-market. For years—ever since the workings were unwatered below the

Sutro-tunnel level, in 1899—several of the north-end mines have been operated with some success, particularly the Mexican and Ophir, and more recently the Union and Sierra Nevada, but now a new development on the 2700-ft. level of the Consolidated Virginia promises to start a general revival throughout the entire length of the great Lode. The Combination shaft, that was sunk jointly by the Chollar, Potosi, and Hale & Norcross mining companies, to a depth of 3300 ft. is to be the scene of renewed activity. This is a great vertical shaft, and has been utilized for years as a pumping and ventilating shaft. As it was an up-cast the heated air, laden with watery vaports, ascended the shaft and condensed on reaching the cool air nearer the surface and fell constantly, drenching the timbers and preserving them from the decay which would have been inevitable had it been a dry down-cast shaft. New electrical equipment is to be installed under the direction of Whitman Symmes, manager for the Middle Mines Association. Through the operations at the Combination shaft, the mines between Virginia City and Gold Hill will be unwatered, as the north-end mines have been through the C. & C. shaft of the Consolidated Virginia.

In the latter mine the south drift on the 2700-ft. level has advanced about 80 ft. in solid ore of fair average grade and stoping has commenced. Raises will be cut in the orebody and the drift extended southward, and cross-cuts run to determine the extent and value of the mineralization, for at present it is impossible to form any conjecture of the size and value that this new discovery may develop. The usual Comstock practice of square-setting has commenced in the stope recently started, and developments will be watched with more than ordinary interest.

Virginia City, April 12.

NEW MEXICO

(Special Correspondence.)—The Buckeye Copper Co. will install new machinery and equipment at its mine near Magdalena. It is owned by William Kemp of Magdalena and Trost Bros., of El Paso, Texas.

Magdalena, April 12.

Grant County

(Special Correspondence.)—The Jumbo Mining Co., which was recently incorporated at Deming with a capital stock of $250,000, will install machinery and equipment for the development of its property. C. J. Kelly, of Deming, is a stockholder.

The Alhambra Silver Mining Co. is being organized by C. C. Royal, of Silver City, for the purpose of taking over the old Alhambra mine in the Alhambra-Black Hawk camp; it is several miles north-west of Tyrone. A cyanide-mill will be installed.

The Pyramid Leasing & Mining Co., which has been incorporated at Lordsburg with a capital of $50,000, will install machinery and equipment for development and operation. William M. Fink of El Paso, Texas, is a stockholder.

Deming, April 11.

OREGON

Jackson County

(Special Correspondence.)—The Nellie Wright mine is on the south slope of Blackwell hill two miles east of Gold Hill, and consists of 40 acres of land. It is situated within half a mile of the Pacific highway. It was recently sold to Salt Lake City people, who are now operating the mine under the management of R. M. Wilson. The former owners were Canadians with P. C. Donovan, of Winnipeg, as manager. The consideration was about $25,000, with a substantial cash payment. This mine is equipped with a 25-ton Beers mill, plates, and a Johnson concentrator. The mill is situated at the main shaft. The shaft is equipped with a modern hoist, and all the machinery is operated by electric power. The new owners are installing compressors and drill-machinery. There are two shafts 130 ft. apart and 50 and 60 ft. deep, respectively. These are connected by a drift which extends 120 ft. beyond the shafts. The ore is chiefly quartz with some pyrite, chalcopyrite, and a dark sulphide that probably is galena. The vein strikes N 75° W., and dips 87° N.; it varies in thickness from 2 to 5 ft. The country rock is the Siskiyou tonalite, which is here traversed by a dike of andesite. The vein cuts both the tonalite and the dike.

This vein was discovered by James F. Davis, a veteran miner of this district, in 1902. The discovery was made on the land of a homesteader who had acquired a patent for the land in the early nineties. Soon after the discovery Davis acquired the property and sold the prospect to Portland parties. The first real development was made in 1904, by Wright, a mining man from Denver, who operated under a lease and option from the Portland people. Financial troubles soon overtook Wright, and he was compelled to abandon his venture before he was able to make a mine out of the prospect. He named it for his daughter, the Nellie Wright mine.

In 1911 the ownership of the property passed to the Canadians, who in 1913 equipped the mine with machinery, developed the vein by sinking and driving as described. In the meantime they operated the machinery for several months, testing the value of the mine. The next year the War came on and the property has been idle until now.

Several thousand tons of ore has been treated with the present machinery. The ore is free-milling, averaging $10 per ton in free gold, and it also produces some concentrate, carrying gold. There is several thousand tons of ore in the block above the 250-ft. drift. The owners are preparing to operate the mine to its full capacity. They will sink 50 ft. deeper in the main shaft and run a new level.

Gold Hill, April 10.

WASHINGTON

Stevens County

The United Copper mine, in Chewelah district, has attained a depth of 100 ft. and will increase production, both in quantity and quality of ore. The company is considering sinking to 1500 ft. and developing the orebody on four new levels. On the 1100-ft. level a drift has been started south, in which direction the rich shoot appears to be widening, being 4 ft. wide, where it was encountered, 22 inches of it containing 21.24% copper and 134.5 oz. silver, with a combined gross value of $222.94 per ton. The full width of the shoot has an average value of $67.97 per ton, and the shoot has an estimated length of 1300 ft. The ore blocked out in the mine is estimated at 300,000 tons with an average value of about $10 per ton. A check for $8283 was received from February shipments of ore and concentrate, bringing the month's receipts up to $31,106, which, with a carload at the smelter not yet settled for, is expected to raise the receipts from February shipments to $56,000. The concentrating-mill is running on low-grade ore and is expected to handle about 150 tons per day. The mine has approximately 35,000 ft. of openings, and, with pay-ore from the surface to the 1100-ft. level, has yielded about $1,000,000 to date.

A carload of ore is awaiting a better condition of the roads from the Iroquois mine, Electric Point district. An adit to intercept the orebody at greater depth is in about 200 ft. with 100 ft. farther to run.

The Providence Mining & Milling Co. has cut a body of $10 silver-lead ore, 27 ft. wide, from the bottom of a 50-ft. shaft, in a new prospect five miles north-west of Northport. Ore accumulating on the dump will be shipped to the smelter as soon as a wagon-road can be built.

A body of $10 silver-lead ore, which can be concentrated 12 to 1, has been cross-cut in an adit 60 ft. from the portal, by the Mineral Belt Mining Co., three miles north-west of Northport. An adit to cut the vein at a depth of 300 ft. is in 200 ft., with 250 ft. to run. The vein is 2 ft. wide.

In the F. H. & C. mine, in Orient district, a vein 14 ft. wide has been intersected in a cross-cut driven 18 ft. from a 30-ft. shaft. Five feet of this ore assays from $25 to $150 per ton in gold and silver. Machinery installed is a hoist, good for a depth of 500 ft., and a two-drill compressor. The shaft will be sunk to a depth of 100 ft. and a level opened.

CANADA

British Columbia

On March 31, the Consolidated Mining & Smelting Co. of Canada, Ltd., closed its mines in Rossland indefinitely. This action is said to have been taken for two reasons, first, on account of the uncertainty of an adequate supply of coke being obtainable from the Crowsnest district of south-east Kootenay, where the agreement between the coal mine operators and the United States Workers of America, which controls the miners and other employees of the coal-mining companies operating in that district has expired, and next, in view of an unexpected concerted demand by the metalliferous miners throughout the district for an advance in wages of fifty cents per day. Practically 500 or 600 men are affected by the company's action.

In connection with the uncertainty of the supply of coke being sufficient for the continued operation of the company's copper blast-furnaces at Trail, it is manifest that no dependence can at present be placed on the Crowsnest district for the output of coke being maintained, for news was received in Victoria recently to the effect that at the Crow's Nest Pass Coal Co.'s colliery at Michel the miners had stopped work, while similar action may be taken any day by those employed at the company's Coal Creek colliery. With the Michel mines and coke ovens idle, the outlook for coke being obtained for the Trail blast-furnaces was less favorable; if the ovens at Fernie shall also be allowed to become inoperative, which must be the result if the miners shall suspend work at Coal Creek, whence comes the slack for burning into coke at Fernie, then the chances for obtaining coke for Trail, Grand Forks, Greenwood, and Northport smelting works will be small indeed.

The official preliminary estimate of the copper production of British Columbia, in 1916, is given as follows:

	Pounds
Northern Coast (Skeena) division	26,056,005
Southern Coast district	18,853,916
Boundary district	16,618,284
Trail Creek (Rossland) division	4,081,500
Omineca division (chiefly Rocher Deboule mountain)	1,262,730
All other districts	884,640
Estimated total	67,757,075

In his comments the Provincial Mineralogist stated that copper-mining is now the most important form of mining in the Province, and in 1916 the value of the copper mined ($18,429,924) exceeded the total value of all other metalliferous minerals, and also exceeded the combined value of the coal and coke production for the year.

KOREA

The Seoul Mining Co., operating the Suan Concession in Whanghai province, Korea, reports the following results for the month of March: Total recovery, $156,760. The Tul Mi Chung mill averaged 460 tons daily. Underground developments at Tul Mi Chung continue to improve. At the Tong Ahm, a prospect, values are improving.

NICARAGUA

The new mill of the Eden Mining Co. in the Pispis district is nearing completion. Tube-mills form a part of the equipment. It is expected that the company will soon be able to start the mill and enter on a long period of prosperity. Numerous American engineers have examined the mines of the district, one of the latest being J. E. Spurr.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

Robert Sticht is at Pasadena.

F. W. Oldfield is in New York.

Robert A. Kinzie is at Bishop, Nevada.

D. M. Riordan has gone to Hanover, New Mexico.

Henry Brings is in San Francisco from El Paso.

Ben S. Revett has returned to San Francisco from Idaho.

E. E. Carpenter of Nevada has returned from Nicaragua.

Charles E. Bruff, of Bradley, Bruff & Labarthe, is at Juneau.

Jacob W. Young, now at Oakland, sails for Valdez, Alaska, on May 8.

H. R. Norsworthy has returned to San Francisco from the Belgian Congo.

Ernest Levy has re-opened his office at 1024 Old National Bank Bdg., Spokane.

J. E. Spurr has returned to Philadelphia from the Eden mines in north-east Nicaragua.

Ross B. Hoffmann returned to Oakland last week from Siberia and is now in New York.

H. J. Sheafe has been appointed superintendent of the Globe mine, in Trinity county, California.

Russ M. Hess has resigned the superintendency of the Stoddard Mines Co. of Arizona and is in New York.

W. A. Pomeroy and W. R. Hamilton have formed a partnership with offices in the Hobart building, San Francisco.

Edmund Juessen has been appointed general manager for the New Almaden Company, at New Almaden, California.

W. H. Landers has resigned as manager for the New Almaden Co. and will offer his services to the Government.

Carlile P. Winslow has succeeded Howard F. Weiss as director of the Federal Forest Products Laboratory, at Madison, Wisconsin.

James W. Abbott, who has been at St. Luke's hospital, San Francisco, for several weeks, has recovered sufficiently to go to Buffalo, New York.

Obituary

William J. Nettle, Sr., who for years has been superintendent of the Argonaut mine at Jackson, California, died at his home at Jackson, April 11, from miners' phthisis. Mr. Nettle was well known to the miners of the Mother Lode, and was one of the capable men who came up from the ranks of the workers.

Research fellowships are offered by the College of Mines of the University of Washington in co-operation with the U. S. Bureau of Mines. The value of each fellowship is $720 per year, beginning July 1, 1917. Fellowship holders will register as graduate students, becoming candidates for the degree of Master of Science in mining engineering or metallurgy, unless an equivalent degree has previously been earned. These fellowships are open to graduates of universities and technical schools throughout the country. Five scholarships are offered, namely, (1) electro-metallurgical processes, (2) beneficiation of coal and non-metallic minerals, (3) clay industry and ceramics, (4) general problems affecting the ores and the mining industry of the State, and (5) the development of metallurgical industries. Applicants must send to the Dean of the College of Mines, Seattle, Washington, before May 15, a copy of their collegiate record issued by the registrar of the institution from which they graduated.

THE METAL MARKET

METAL PRICES

San Francisco, April 17

Antimony, cents per pound	24
Electrolytic copper, cents per pound	37
Pig lead, cents per pound	9.25—10.25
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$115
Spelter, cents per pound	12
Tin, cents per pound	50
Zinc-dust, cents per pound	19—20

ORE PRICES

San Francisco, April 17

Antimony, 50% metal, per unit	$2.00
Chrome, 40% and over, f.o.b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tungsten, 60% WO_3, per unit	16.50—18.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 50% (under 35% metal not desired), cents, unit	35—40

Manganese ore, 40 to 45%, sells f.o.b. Chicago at 58c. per unit with a penalty of 50c. per unit for more than 8% silica.

EASTERN METAL MARKET

Owing to interruption of telegraphic communication east of Denver on the day of going to press, it has been impossible to obtain market quotations from New York by wire as usual.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
Apr.	4	Feb. 27	36.00
"	5	Mch. 6	36.29
"	6	" 13	36.25
"	7	" 20	35.87
"	8 Sunday	" 27	35.62
"	9	Apr. 3	34.58
"	10	" 10	33.83

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
Apr.	11	Mch. 6	76.50
"	12	" 13	75.06
"	13	" 20	72.91
"	14	" 27	72.06
"	15 Sunday	Apr. 3	72.98
"	16	" 10	73.72
"	17	" 17	73.27

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

Coinage at Philadelphia mint for March was: Half dollars, 462,000 pieces; quarter dollars, 2,620,000 pieces; dimes, 7,050,000 pieces; nickels, 566,942 pieces; cents, 6, 709,550 pieces. There were also made 10,000 coins for Peru.

During the past year fluctuations in the price of silver have been extreme, ranging from 26 11-16 to 37 1-8d. ($0.54 to $0.75 United States gold), the lowest quotation being in January and the highest in May. The coinage demands of the belligerent countries, including the expenditure on military operations in Egypt, East Africa, and Mesopotamia, have been a contributing cause to the remarkable rise in the price of silver, but the rise was chiefly due to the purchases made by the Indian Government, which bought during the course of the past 12 months some £15,000,000 ($72,997,500 United States gold at exchange of $4.8665) worth of silver. The balances in the Indian Currency Reserves were reduced by 16 crores of rupees ($51,909,330 United States at exchange of $0.32443) between August 1915 and March 1916, and had to be replenished by large purchases of the metal, the urgency of which has been in no way diminished by the heavy withdrawal of rupees that is still going on.

These demands of the Allied Governments for coinage and of the Indian Government to replace the enormous absorption of silver rupees by the natives of India, where gold was not available for hoarding purposes, have more than kept pace with supplies. Outside sources of supply were tapped; the equivalent of 8,350,000 standard ounces was obtained from the Government of the Philippines in the form of peso coins, and the movement of silver funds into gold securities necessitated a heavy export of silver from China. During the year under review these exports amounted to about 19,000,000 oz. In addition to the above, about 9,000,000 oz. was exported to India from Hongkong in the form of dollars and subsidiary coins. There is, therefore, no escape from the conclusion that the amount of silver left in China must be barely sufficient for trade requirements; and assuming, as we have every reason to, that there will continue to be a strong demand for the products of China, it would appear inevitable that China must again be a competitor in the silver market.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
Apr.	4	Feb. 27	9.45
"	5	Mch. 6	11.54
"	6	" 13	9.50
"	7	" 20	9.75
"	8 Sunday	" 27	9.50
"	9	Apr. 3	9.40
"	10	" 10	9.35

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date		Average week ending	
Apr.	4	Feb. 27	10.70
"	5	Mch. 6	10.85
"	6	" 13	10.87
"	7	" 20	10.69
"	8 Sunday	" 27	10.74
"	9	Apr. 3	10.71
"	10	" 10	10.64

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Mch.	13	105.00	
"	20	115.00	
Mch.	27	120.00	
Apr.	3	115.00	
"	10	115.00	

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Foreign tin stocks: The London tin stocks on March 10, 1917, were as follows: Straits and Australian, 1563 tons; Banca, 247 tons; Billiton, 37 tons; Chinese, 68 tons; and English, 58 tons, making the total 1973 tons, compared with 1896 tons of March 3.

The Liverpool tin stocks on March 10 were as follows: Australian, 10 tons; Banca, 275 tons; Billiton, 64 tons; and English, 47 tons, making the total 396 tons, compared with 486 tons on March 3.

ANTIMONY

The demand in New York for spot antimony is a little less on account of arrivals having met the immediate requirements, and the nominal quotation is 34 to 35c. for prompt delivery. Forward antimony is still offered at 13½c. Spot needle antimony has realized 13c. per pound. Antimony ore is hardly obtainable and the nominal quotation is $2.50 to $2.75 per unit for first-class high-grade ore.

PLATINUM

The price of platinum remains unchanged at $105 for the soft unalloyed metal, and $111 for the hard natural platinum-iridium alloy.

Eastern Metal Market

New York, April 11.

Practically all the metals are without feature and lifeless, even more so than last week. There is an absence of any interest and even the official recognition of a state of war has failed to bring about any decided activity.

Copper has continued to decline and is heavy and dull.

Zinc is manifesting considerable weakness which has increased in the last day or two.

Lead is firm and steady with no change in prices.

Tin is less active than for some time but is firm.

Antimony is still nominally unchanged.

Prices for steel for Government war needs have been settled upon with the producers and the prices as arranged are 2.90c. for plates and 2.50c. for bars and structural shapes. At least 300,000 tons are at once involved with still more buying to come later. These prices are no hardship for the United States Steel Corporation, but may be a decided one for some smaller producers. The labor problem is to be a difficult one as time goes on and recruiting increases. Prices are still advancing for pig-iron, finished steel, and old material. Basic iron has gone from $35 to $40 at Valley furnaces with Bessemer iron up from $39 to $42, while scrap has advanced $2 to $3 per ton.

The monthly statement of the Steel Corporation shows the largest unfilled orders ever recorded—11,711,644 tons—an increase of 134,947 tons over those at the close of February.

COPPER

Whether American producers will be called upon to sell large quantities of copper to the Allies for delivery in the last half, and if so at what price, is the dominating influence in the market. Opinions in the trade differ as to the probable price, for the supplying of large amounts is taken for granted. Some think the metal will go at 16.67c. per lb., while others expect a price of 20c. or perhaps as high as 25c. Uncertainty as to the outcome of these factors has exercised a repressing tendency among buyers and the market is heavy and dull. In fact, there are more sellers than buyers and the market has constantly receded the past week. Today nearby and April electrolytic and Lake copper are quoted as low as 33c., New York, with May and June at 32 to 33c. and third quarter at 29 to 30.50c., all New York. Last week future copper—July, August, and September delivery, was obtainable as low as 29.50c., New York, with offerings later at 29c., but little buying was reported. The London quotation for spot electrolytic was unchanged at £151 yesterday.

TIN

The market is devoid of interesting features and sales have been very light the past week. On April 5 a moderate business was reported as done quietly in future shipments from the East. Early this week a little business was done in spot metal at 54.50 to 54.60c. and more could have been transacted if sellers had been willing. Yesterday there were inquiries for at least 100 tons but no business resulted. The market has assumed a dull tone and the declaration of war has not been thus far a bullish factor. Considerable interest has been taken in the announcement of a new plant to smelt Bolivian tin ores in the United States. A new corporation, the Williams Harvey Co., in which the National Lead Co. has bought a half interest, and which is closely affiliated with the largest tin producer in Europe, the Williams Harvey Co., Ltd., of England, has bought 9 acres of land on Jamaica bay, Long Island, and will at once put up one unit which will produce 300 tons of tin per month. This metal will not come into the general market directly but will be absorbed by the National Lead Co., already one of the largest users of tin in this country. A saving of at least ½c. per lb. is considered certain, that amount being the freight on tin from England to New York. The opening of the Panama Canal has made this project possible. Bolivian ore, formerly sent to England around Cape Horn, now goes directly to England through the Canal. The quotation yesterday for spot Straits tin was 54.62½c., New York. The arrivals thus far in April have been 1490 tons, with the amount afloat at 3012 tons. The London quotation for spot Straits yesterday was £216 10s., an increase of over £2 above that of last week.

LEAD

The lead market is unchanged and steady. Very little business has been reported though some was done last week at 9.37½c., delivered at Eastern points, which is higher than the St. Louis quotation of 9.15c. The New York price has stood at 9.35c. the entire week with the St. Louis quotation at 9.15c. A rumor has been circulating that a price of 4.70c. per lb. has been agreed upon between producers and the Government, but its confirmation has not been possible. If anything has been decided it is not generally known. Opinions differ as to just what such a price should be, very few placing it as low as 4.75c. per lb., the average price for the last 10 years. Some regard this as too low—lower than the cost of production for some smelters at present. Some place the expected price at 5.50 to 6c. per pound.

SPELTER

The market is lifeless and weaker. Prompt and April metal can be bought today for 9.75 to 10c., St. Louis, and some even say that this can be shaded. Uncertainty as to the future and an entire absence of demand in any large volume have caused the previously stagnant market to change to a weak one. Offerings are being freely made, some producers appearing willing to sell future metal at a loss, ore prices not showing much change. Export figures are no longer available because of the War, which has not thus far been a bullish factor in this market.

ANTIMONY

There is very little change since last week. The nominal quotation is 36c. for spot metal with a few sales reported at 36 to 37c. Early-delivery metal is somewhat more plentiful than a week ago.

ALUMINUM

Spot metal is still 59 to 60c. for No. 1 virgin aluminum, 98 to 99% pure. The Government has made no purchase yet.

QUICKSILVER

The past week has seen quite an active market for quicksilver, which, though quoted nominally at $120 per flask, was obtainable at a concession from this figure, and the leading parties reduced their price to $115 per flask. This price refers to Californian virgin quicksilver.

ORES

TUNGSTEN. One broker reports sales for the week of over 500 tons of tungsten concentrate at $16.50 to $18 per unit, depending on the quality. The entire market is more active than for some time, with Europe a decided factor. Italy is reported to have bought 200 tons of ferro-tungsten at $2 per lb. of contained tungsten, for delivery during the year.

MOLYBDENUM. Because of inability to secure ore, a contract for 30 tons of ferro-molybdenum was cancelled, according to one broker. The ore situation is not satisfactory and quotations are irregular. A new company is making ferro-molybdenum in electric-furnaces at Boonton, New Jersey.

ANTIMONY. The ore continues difficult to secure and therefore the quotation is nominal at $2.50 to $2.75 per unit.

Company Reports

JUDGE MINING & SMELTING CO.

Annual report of the Judge Mining & Smelting Co. for 1916.

RECEIPTS

Balance January 1, 1916	$ 678,906.56
Total ore sales	839,455.29
Interest earned	52,815.94
Sale of capital stock	1,320,000.00
	$2,891,177.79

EXPENDITURES

Mine account	$ 256,507.88
Mill account	71,287.03
Prospecting, deadwork, etc	188,462.21
Ore expense	19,666.81
Dividends	435,000.00
Drainage	12,000.00
Miscellaneous expense	39,750.00
Purchase of property	1,310,179.96
Total expenditures	2,335,887.98
Balance, December 31, 1916	555,289.81
Total	$2,891,177.79

CENTENNIAL COPPER MINING CO.

The directors submit the following report of the operations of this company for the year ended December 31, 1916:

Gross value of fine copper produced:

2,367,400 lb. sold at 25.02c	$592,268.76	
Interest and miscellaneous receipts	2,545.92	
		$594,814.68
Running expenses at mine	$288,506.84	
Smelting, freight, commission, Eastern office, etc.	29,761.58	
		318,268.42
		$276,546.26
Less assessments account of the L. M. S. & R. Co.	$ 11,296.28	
Dividend No. 1, paid September 21, 1916.	90,000.00	
		101,296.28
Increase in current assets for the year		$175,249.98
Balance of current assets December 31, 1915		273,118.50
Balance of current assets December 31, 1916		$448,368.48

BUNKER HILL & SULLIVAN

The Bunker Hill & Sullivan Mining & Concentrating Co.'s report for the year ended December 31, 1916, shows the following: Total ore mined during the year, 475,784 tons, for an operating profit of $1,867,791.97. The cost of mining per ton of concentrate produced was $14.74; cost of milling per ton of concentrate, $3.75. The cost of transportation, smelting, and other incidental expenses was $38.74, and the total cost per ton of concentrate was $58.17. Other sources of revenue than ore treated brought the total operating profit for the year to $2,365,040.31. Dividends were paid during 1916 amounting to $1,716,750. There are calculated to be still available in the property ore reserves blocked out as follows: In the Stemwinder mine, 9561 tons; in the Sullivan mine, 722,305 tons, and in the Bunker Hill mine 2,721,280 tons, making a total of 3,453,146 tons. The gross surplus valuation of the property, December 31, 1916, was $45,052,211.50.

COPPER RANGE COMPANY

The directors present the following consolidated statement of the operating companies for the year ended December 31, 1916:

54,747,498 lb. of copper produced and sold at average of 25.28c. per lb		$13,840,167.49
Interest		69,868.51
		$13,910,036.00
Mining expenses, including smelting, freight, marketing, etc.		4,771,398.83
		$9,138,637.17
Taxes		327,194.97
		$8,811,442.20
Atlantic Mining Co. profits without deducting taxes	$ 17,225.43	
Copper Range Railroad Co. net income without deducting taxes	202,600.08	
		219,825.51
		$9,031,267.71
Deduct net expenses of Copper Range Co.	$ 17,774.93	
Deduct one-half of net mining profit of Champion Copper Co. which belongs to the St. Mary's Mineral Land Co.	2,935,303.13	
		2,953,078.06
Net income for 1916		$6,078,189.65
Dividends paid during the year		3,941,648.00
Balance of income for 1916 added to working capital		$2,136,541.65

UTAH CONSOLDATED MINING COMPANY

Profit and loss account for the year ended December 31, 1916.

EXPENDITURES

Mining, including operating aerial tramway	$1,078,670.67
Exploration and development	308,842.32
	$1,387,512.99
Smelting	1,389,386.96
Administration, including corporation, State and income taxes, and miscellaneous expenses	64,482.59
Legal and professional charges, traveling and sundry expenses	8,402.94
Balance, being profit for year	1,924,176.85
	$4,773,962.33

RECEIPTS

Proceeds of sales of copper, silver, gold, and lead	$4,551,480.56
Less refining charges, freight, selling expenses, and insurance	191,756.88
	$4,359,723.68
Add stock of bullion on hand at end of year	1,410,018.89
	$5,769,742.57
Deduct stock of bullion on hand at beginning of year	1,075,304.35
	$4,694,438.22
Sundry	9,627.03
Dividends, Anaconda Copper Mining Co	57,750.00
Interest	12,147.08
	$4,773,962.33

Mining and Scientific Press

Edited by T. A. RICKARD

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Number 17

SAN FRANCISCO, APRIL 28, 1917

15 Cents per Copy
$4 per Year

AN INDEPENDENT PAPER OWNED, EDITED, AND MANAGED BY ENGINEERS

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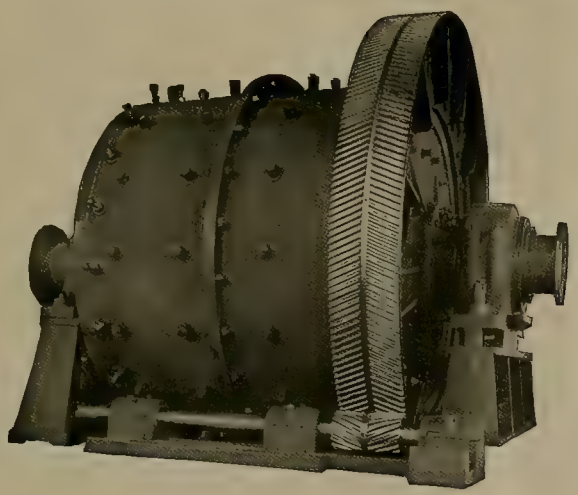

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Methods of Mining
Belgian Relief and American Engineers

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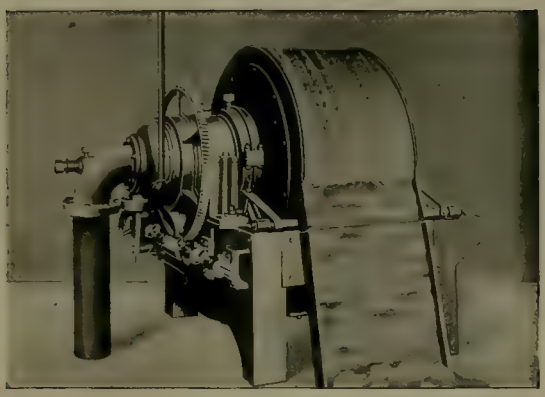

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Science has no enemy save the ignorant

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UNION CONSTRUCTION COMPANY

The Union Construction Page

UNION CONSTRUCTION COMPANY

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of
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EDITORIAL

T. A. RICKARD, Editor

SPADE and shovel, the spade of the farmer and the shovel of the miner, must be plied lustily in order to sustain our national effort in the War. The pick of the miner will aid the pick of the sapper in digging the road to peace.

THE long arm of coincidence has brought our editorial on Mr. Kinzie's article discussing 'Methods of Mining' alongside our regretful comment upon the subsidence at Treadwell. Truly this question of how to work big low-grade orebodies is a vital one.

SEVEN billions is an enormous sum of money, but the bond issue of today is easier for the United States to digest than the $500,000,000 raised in 1862. Then the wealth of the nation was $16,000,000,000; now it is $230,000,000,000. The population now is three times what it was then. The Government had to pay 6% in 1862; it will pay 3½% in 1917.

JAMES A. PATTEN, Arthur Cutten, and other traders at Chicago have announced that they have ceased to speculate in grain, as "an act of patriotism." This is a commendable act, for it does mean a financial sacrifice. To these men speculation is meat. Their action is far more patriotic than that of the worthy people who are willing to operate their manufactories on a 10% profit guaranteed by the Government. At that kind of sacrifice one may smile cynically.

METAL prices have been inflated during the course of the War to a degree that threatened a dangerous collapse of industry—and of such speculation as stimulates the mining industry in particular—when the necessary readjustment begins. The recent sale of copper to the Government at a price that is the average for the last decade indicates how the readjustment may be effected without any panic. It will enable the big producer to co-operate with the Council of National Defence not only in procuring a supply of copper and other metals at a reasonable price but it will permit Mr. Bernard Baruch to work with his fellow-speculators and market-operators in bringing prices back to a normal level, that is, to one likely to hold when the War ends.

DAYLIGHT-SAVING is a most desirable economy. A plan that has met with favor abroad, and that is threatened in the United States by a bill pending in Congress, is to play a huge national joke, setting the clock ahead and scaring people out of bed at 5 a.m. under the belief that it is really 6. The sentiment of the victims toward the time-piece convicted of telling a lie regarding the relation of the sun to the local degree of longitude, is likely to be expressed in explosive language. Wherein the scheme will save more time than by merely blowing the whistle earlier on summer mornings is difficult to see. In all seriousness it would seem that the end sought might be attained with less disturbance of the settled order of things by a general agreement to begin work at an hour that would take advantage of the earlier dawn. The farmer has always done this without juggling with the clock. These changes, moreover, would disarrange the railroad schedule twice each year, and in railroad operation the familiar time-table is the safer. The idea is more amusing than important.

IN the death of Frederic Anton Eilers this country loses a metallurgist and a man to whom the mining industry is under lasting obligations. The history of Western smelting cannot be written without paying tribute to his genius as a leader. He combined the faculties of a progressive man of affairs with those of a highly trained technologist possessed of the constructive imagination that opens new paths for progress. He has justly been called the father of American lead smelting. Seventeen years after landing in this country he had established the Germania smelter, near Salt Lake, and three years later, in 1879, he was a dominant figure in the Leadville district. His grasp of the opportunities offered by the West found its expression in the smelter at Pueblo, Colorado, built in 1883 by the Colorado Smelting Company, of which he was president. Thus was founded an enterprise at a point chosen with such rare understanding of the relations of available supplies of ores and fuel, and of transportation both for raw materials and finished products, that the works then established became conspicuous among the smelting plants of the United States. The several enterprises created by him constituted one of the most important groups entering into the combination in 1899 that made the American Smelting & Refining Company. Anton Eilers represents one of several distinguished engineers and metallurgists attracted from Germany by the discoveries of great mines in this country at a time when we lacked men capable of dealing with the scientific problems presented. He was born at Nassau, Germany, in 1839, graduated from the Mining School at Clausthal and the University of Göttingen, and threw his talents into the unfolding of the metal resources of the United States in 1859. To him the War seemed a terrible calamity from the first and to him the final participation of the United States in the contest against Germanic aggression must have been a bitter blow. It is

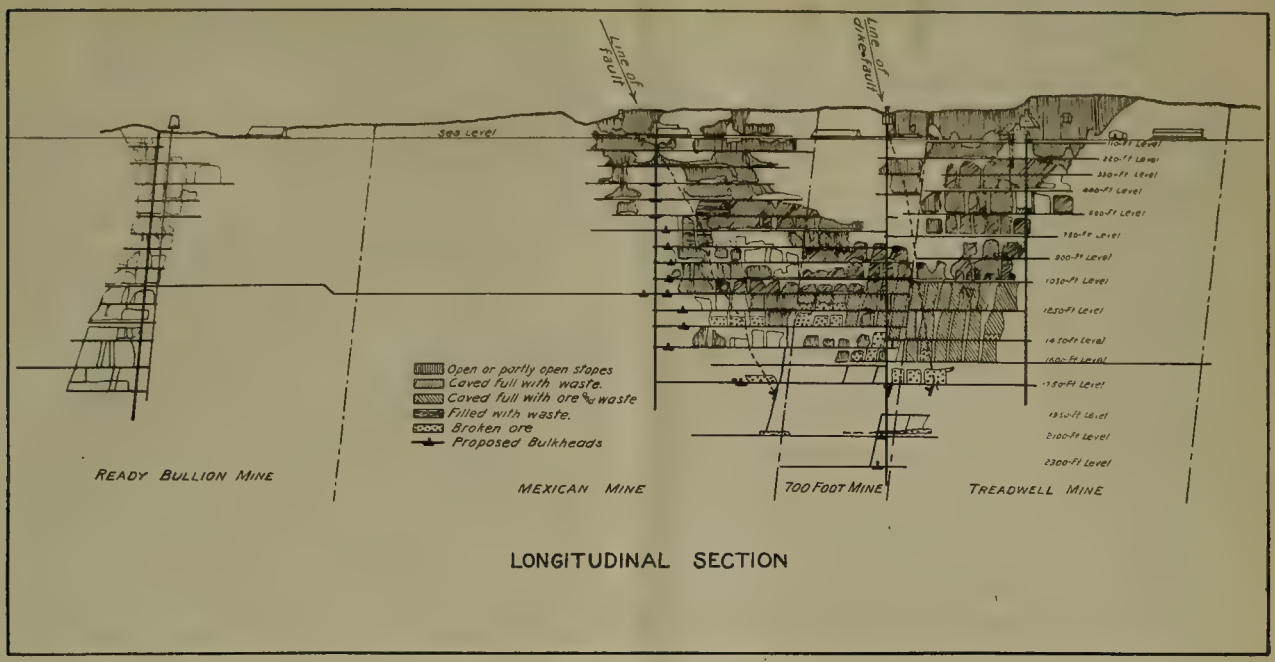
one of the tragedies of our time that citizens so useful and honorable, after a life of effective service in the cause of American industrial and technical development, should find themselves pulled by opposing ties. To the old the undermining of faith in the orderly development of human affairs is a shock such as the young, with their optimism, are spared. To us and to many of our readers the passing of Anton Eilers is the breaking of a link with the past, the close of a heroic period in technology, and the loss of a greatly honored friend.

The Treadwell Subsidence

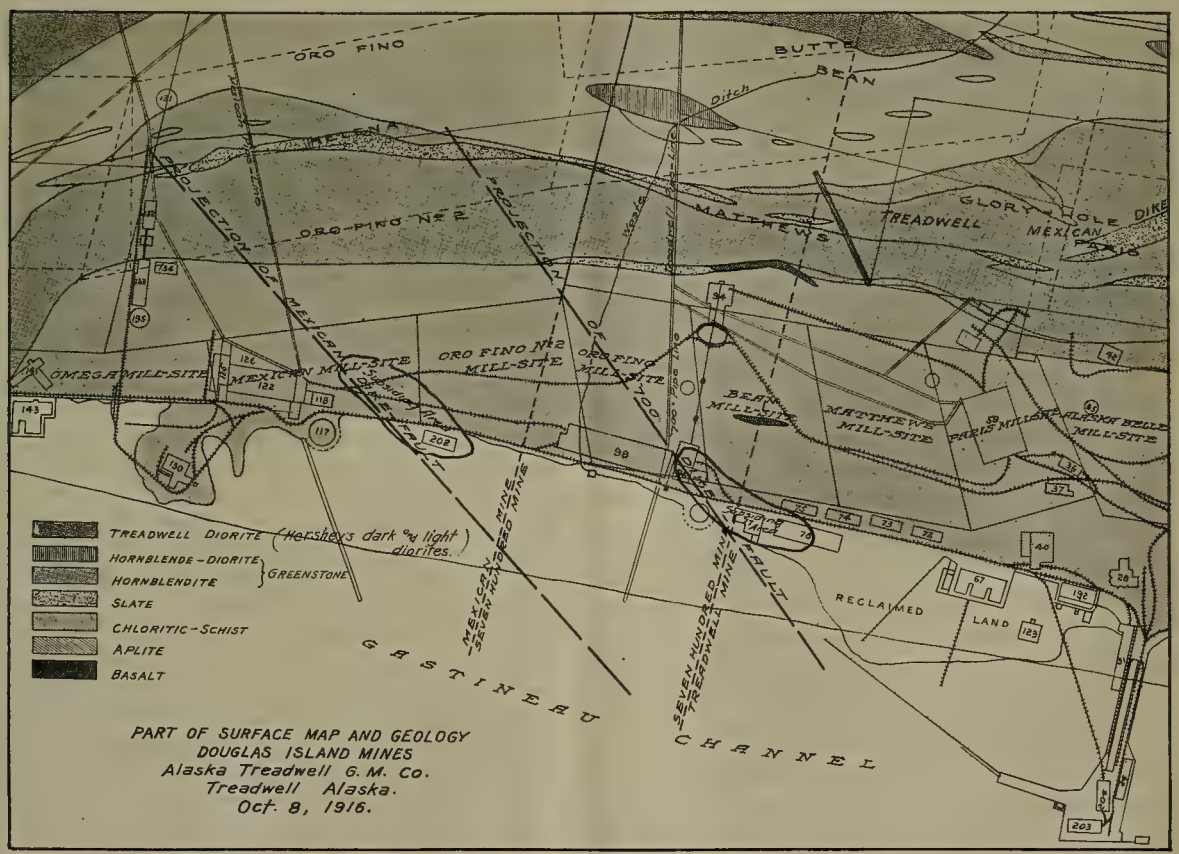
Late on the night of April 21 the workings of the Alaska Treadwell, Alaska United, and Alaska Mexican mines had to be abandoned on account of an inrush of water from the sea, that is, Gastineau Channel, the strait separating Douglas island from the mainland. Fortunately ample warning was given, so that no lives were lost. The locality of the subsidence is shown on the accompanying map, it being the rounded space marked 'Subsidence Area' extending for 250 feet on each side of the boundary between the Treadwell and the 700 Ft. mines. An intermittent settling of the ground in this locality has been noted since July last. Another area of subsidence is shown over the Mexican mill-site, but this has given no sign of movement recently. These two danger-spots are immediately related to the respective faults along the two dikes, as indicated on the map; both are on the edge of the old shore-line, which, by discharge of tailing and other filling, has been extended about 500 feet into the channel, as the map shows. The final collapse came suddenly, but watch had been kept at each known area of settling so that the evidence of further caving was detected on the surface and reported in time to permit the men to escape from underground. Then the water broke through the cracks and filled the three mines that are contiguous. Luckily the Ready Bullion mine is separated from the others, and the only connecting working, the 1350-ft. level from the Mexican, had been carefully bulkheaded in two places. The latest report states that the bulkheads are holding, so that the Ready Bullion mine is likely to be saved. To what extent the position may be retrieved cannot be known immediately; if the subsidence does not go too far, that is, if the caving does not reach out along the fault so as to present a larger opening to the sea-water, there will be a chance of surrounding it with a coffer-dam, and thereby re-winning the three mines now completely drowned. If that cannot be done then the Ready Bullion shaft can be sunk and drifts extended to tap the virgin ground under the lost workings of the three other mines. This deeper ground has been giving promise of improvement in gold-content, as explained in our last issue, and it is protected from caving by several hundred feet of unstoped rock. The staff, more particularly their chief, Mr. F. W. Bradley, are not the kind of men to throw up their hands helplessly so long as engineering skill can save the mines or any part of them. Fortunately Mr. J. H. Mackenzie happens to be at Juneau just now and his mature experience is at the service of the local management. Our readers will find further information on the subject in our issue of February 10, this year. The three mines immediately affected by subsidence and flooding have produced 22,661,748 tons of ore yielding $54,886,968 in gold, from which a profit of $23,072,567 has been earned from August 1885 to June 1, 1916. The reserves of ore amounted to 6,000,000 tons, besides about as much more in pillars and caved ground. The Ready Bullion mine, of the Alaska United company, has produced 3,802,299 tons, yielding $7,910,491, of which $1,966,011 was profit. The three companies have distributed $21,337,651 in dividends during their lives. We give the hand of sympathy to the members of the staff at Treadwell, to whom the event must seem calamitous. As regards the force of workmen, it happens that a scarcity of labor exists in south-eastern Alaska, owing largely to the work on the Government railway from Anchorage, so that any men discharged from Treadwell will be welcomed at Juneau, where the shortage of labor threatened seriously to interfere with the success of the Alaska Juneau operations, now coming to fruition.

Methods of Mining

No part of the technology of mining is so scanty and unsatisfactory as that which deals with the breaking and removal of ore underground. The reasons for this lack of information are not far to seek. In the first place the large-scale exploitation of mines is comparatively recent; there was very little of it in the days when the elders in the profession were students in a school of mining. However, the newness of the subject would not have prevented the growth of writings concerning it except for the fact that underground methods of work are difficult to describe and those most familiar with the details are usually least able to write with pleasure to themselves or with profit to others, while among those that can write skilfully very few have had much to do with the more intensely practical phase of the subject. Exceptions fortunately exist. In this issue we publish the second part of an article by Mr. Robert A. Kinzie, for ten years the general superintendent of the Alaska Treadwell group of mines. Mr. Kinzie is not only familiar with the technique of underground work through long experience as the manager of big mines, but to his scientific training at the University of California he has added the ability to write clearly, an ability, we venture to say, not acquired by inspiration from on high, for that is not the source of literary skill, but by a painstaking and intelligent effort to use words as if they were weapons of precision. Indeed, we recommend the article on 'Methods of Mining Big Orebodies' to the younger members of the profession as one of the best examples of good technical writing that has come under our notice. As an editor we would gladly offer libations to Clio, or whichever muse it be that presides over this part of human endeavor, if only we could have more writing of the same kind.



THE TREADWELL GROUP OF MINES. THE AREA OF SUBSIDENCE IS AROUND THE DIKE-FAULT IN THE 700 FT. GROUND.



GEOLOGIC MAP OF THE TREADWELL PROPERTIES. THE LOCALITY OF THE SUBSIDENCE IS THE ELLIPTICAL AREA ABOVE THE WORD 'CHANNEL.'

Mr. Kinzie's article discusses the method of mining most suitable to the conditions obtaining in the mines on the Alaskan mainland, near Juneau. These mines have come into prominence during the last three years by reason of the enormous scale on which the Alaska Gold Mines, controlling the Gastineau group, which includes the old Perseverance and contiguous properties, is being exploited, also on account of the expansion of the Alaska Juneau enterprise, which is in the hands of the highly capable engineers identified with the management of the Treadwell group on the adjacent island of Douglas. The first condition to consider is the low gold-content of the ore, the average being $2.55 in the Treadwell mines, $1.50 in the Gastineau, and $1.60 in the Juneau. Next is the width of ore, varying from 400 feet in the Treadwell dike to 900 feet in the Gastineau-Juneau lode-channel. Any method of extraction must be based on a careful diagnosis of the geologic structure. Mr. Kinzie describes this with admirable clearness. The zone of mineralization is as much as 3000 feet wide, but the workable portion is about 900 feet wide. This is not a homogeneous orebody; it consists of alternating bands of ore and waste dipping at a steep angle, ranging from 60° in the old Perseverance workings to 30° on Mount Juneau. In the Juneau mine the dip is 55°. The ore is either in schist or meta-gabbro, both of which have been crushed and sheared, and then penetrated by veinlets of gold-bearing quartz. The gold is found in the quartz, but only where the sulphides of lead and zinc abound. The problem is to remove as much of the gold-bearing quartz with the least amount of barren rock, and to do it on a scale sufficiently large to make money out of a mill-feed that assays $1.75, or even less, per ton. The Alaska Gold Mines company is now treating 9000 tons per day and expects eventually to treat 14,000 tons per day, whereas the first unit of the Alaska Juneau mill was started last week, crushing 1000 tons per day, an amount that is to be increased gradually to 8000 and possibly to 12,000 tons daily. To supply mills of this capacity with ore yielding a profit is a task fit for an engineer of the most resourceful type. It must be done with due regard to the safety alike of the mine and the men. At Treadwell, as our readers are aware, the method of excavation is what is known as 'back-stoping,' that is, by under-cutting the orebody and stoping the ground by blasting from the backs, the men standing on the broken ore as it accumulates under-foot. No aid is expected from caving, which indeed is not desired, all the breaking being done by mechanical methods; in short, by man and not by nature. Apparently Mr. Kinzie considers that, of the various methods he has described, the second and fourth are best adapted to the Juneau ground as at present developed, and he recommends the fourth method for the Gastineau. The last method was developed by the late John R. Mitchell in the course of his experience as superintendent of the Perseverance mine and in friendly consultation with Mr. Kinzie at the Treadwell. To Mitchell, a fine type of mine-captain, will be due a large measure of credit for the successful exploitation of these Alaskan low-grade orebodies, and it is deeply regrettable that he did not live long enough to see the result of his pioneer work. His first stoping in the slate, above the Alexandra adit, was started on a back-stoping or Treadwell plan and he soon got into difficulties, which he was quick to recognize, with the result that he modified his practice in order to lessen the obvious danger, it being impossible to put men to work under the hanging wall. Thus he changed gradually to a method of blasting from the foot-wall, allowing the hanging to cave at the proper time by leaving a thickness of ore, ranging from 2 to 25 feet, to delay the collapse of the hanging until the broken ore had been drawn. The point most emphasized in Mr. Kinzie's article is the use of bulldozing-chambers in connection with back-stoping. This chamber may be defined as a recess wherein the breaking of large pieces of rock may be performed by men under cover. Mr. Kinzie evidently has a strong belief in the efficacy of such an accessory to the stopes as affording a means for reducing the cost of mining and decreasing accidents to the men. The bulldozing-chamber gives a fine chance to confine the use of explosives to a limited range and away from places where men are operating machine-drills. This method also facilitates proper ventilation, for the chamber diminishes the proportion of fume and smoke in the stopes. It must be remembered that the author of the article, besides his work at Treadwell, was general superintendent of the Juneau for nine years and has been enabled to test this system on a fairly large scale. His treatment of the subject is not academic. Indeed, every method discussed in the article has undergone practical test by the author himself, for which reason his suggestions are of unquestionable value. Mr. R. G. Sampson in his recent article, appearing in our issue of April 7, described a method resembling Mr. Kinzie's third scheme, but Mr. Sampson's method is adapted particularly to orebodies of the horizontal type, under an overburden, as at Ray, especially in relation to the recovery of stope-pillars. He refers to the loss of ore incidental to this kind of mining, and on this we may remark that such loss can be decreased by stoping from intermediate cross-cuts, so as to remove the stope-pillar before it is surrounded by the waste, which dilutes the broken ore. The reclaiming of pillars is a large detail, too often overlooked or insufficiently regarded. Upon it, of course, depends the success of the method. It should be unnecessary to emphasize this phase of the subject. The future production of gold, copper, and lead, as of other metals probably, will come from immense masses of low tenor similar to those constituting the Juneau and Treadwell mines, which differ from the disseminated copper mines in Utah, Arizona, and Nevada in that they are based on the exploitation not of nearly horizontal layers or zones of ore but of the steeply inclined type of lode. Hence any information on the subject is of the greatest value to the engineering profession. Therefore we invite discussion of Mr. Kinzie's article, knowing that intelligent criticism is the kind of compliment that he will most appreciate, as we also shall most welcome.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Hogging Mineral Land

The Editor:

Sir—The gold output of the United States during 1916 decreased over $8,000,000, and the current year will probably record another decline. The PRESS has devoted considerable space to prospectors and prospecting, giving some of the reasons why the search for gold, for instance, has fallen off. A recent trip through Mariposa county, California, enlightened me on another phase acting against the discovery of new mines, namely, the 'hogging' of large areas of mineralized land by a few companies. Motorists and others understand the phrase 'hogging the road,' so miners will see the significance of the title to this note. Mariposa county is the most southerly of the Mother Lode counties, with an area of 1463 square miles, and while the counties to the north are busy, Mariposa is decidedly dull. Why? Three instances should suffice to answer this: One is the Mariposa grant of 44,000 acres of patented ground, on which no mining is being done. Near Coulterville the Merced Gold Mining Co. has watchmen only looking after its Mary Harrison and other claims extending over a mile on the Mother Lode. This patented ground has not been worked for 15 years or so, although it was recently sampled. The Peñon Blanco and other patented claims of the Oro Rico Mines Co., having a length of over a mile on the Lode, have not been operated for five years or so, and employ only a watchman. Leasing on these three large properties is not encouraged, neither is prospecting; consequently the county suffers. Conspicuous outcrops are traceable for miles, and should contain shoots of gold ore. Such a condition should not be allowed to continue. Some system of taxation or labor requirements, such as is enforced in Australia, would compel the companies to give up part of their ground, or encourage prospecting and leasing on easy terms. This hogging the land is a great detriment to the industry.

Another drawback to mining in Mariposa county is the lack of electric power. Two companies supply part of the region, but they cannot be expected to extend their transmission-lines unless mining expands. Those companies which are at work must suffer this power shortage until mining operations are started on the large patented areas. Fuel is scarce in these districts, so electricity is what is needed.

In the county at present the Champion, McAlpine, Mountain King, Virginia, Ruth Pierce, and other mines are being actively worked or are under development. Near La Grange a dredge is working along the Tuolumne river, while near Merced Falls the Yosemite Dredging Co.'s boat is digging profitably in river-flats, some of them agricultural lands.

Something is necessary to enliven gold mining in this promising county, and the elimination of large holdings of patented ground would help considerably.

M. W. VON BERNEWITZ.

San Francisco, April 10.

Good Work Underground

The Editor:

Sir—I have been reading various articles of late in your paper referring to what should constitute a shift's work, that is, the footage a man should drill per day, the distance he should tram, the distance a crew should drive in a tunnel, and the bonus system as compared with contract.

I will give you an actual case covering all these points. We are driving a cross-cut tunnel 4½ by 7 ft. in the clear. The rock is hard slate and dry, with only occasional small seams or watercourses, which soon drain off after cutting. During the month of March we drove 367 ft. There are two men on a shift and they use a jack-hammer without the bar or water attachment. They use muzzles only to protect them from dust. We are working three shifts of 8 hours each. The two men remove the dirt left from the round of the previous shift and put in their round of holes to a depth of 4½ ft., which is all the succeeding shift can handle and get their round in within their time. They average 8 holes per round, or about 32 ft. They lay their track up to the face, place the turn-sheet on top of the track, and blast on top of it. Then the next shift is ready to go to work.

Our ventilation is a small jet of compressed air turned into a 6-in. thin galvanized-iron pipe. The jet is carried all the time as close up to the face as possible without being blasted out. The tramming distance of last month was at the start 1020 ft. and at the end of the month 1387 ft. The two men on shift change with each other on each car-trip. The car holds 26 cu. ft. and they heap about three cubic feet more on top. Two men follow up with the timber. They cut and drag in their timber on the snow a distance of about 300 ft. and put in on an average of about 50 sets per month, about one-third of it lagged up on both sides as well as the top. A mechanic comes to the tunnel every other day and puts in the needed ventilation-pipe, moves the jet forward, and adds air-line.

We use about a half a box of dynamite per shift. We had trouble with mis-fires for a while, but as T. T. Edwards wrote in your issue of March 24, there are only

four reasons for mis-fires. We investigated the four reasons and found defective fuse and caps. We also find that there is a big economy in using strong caps. We use the best fuse on the market and an 8x cap with 40% gelatine powder and now have no trouble with mis-fires or 'stinkers.' Our primers are made and placed just as Mr. Edwards advises.

We pay a bonus to the six men of $3 per foot for all the footage they make over 210 ft. for the month. The bonus is divided among the six in proportion to the days they put in during each month. They are paid $4 per day for their 8 hours work. Although we are 40 miles from the nearest town, we have no difficulty in replacing a man on this tunnel-work, as soon as anyone wants to lay off. We think we have come pretty close to the record for six men at that distance of tramming and under the conditions as described. I must state also that during the month, for various reasons, four shifts failed to get in their rounds, which meant 367 ft. in 87 shifts or 4.218 ft. per shift.

Do you think we approached a record?

J. A. WILLEY, Superintendent.

The Bachelor Mine, Stemple, Mont., April 4.

Nitrogen Gas in Metal Mines

The Editor:

Sir—The article by E. Steidler of the Bureau of Mines in your issue of March 11, 1916, describing a gas of almost pure nitrogen which occurs in the Tonopah-Goldfield district of Nevada, reminds me of several occurrences of what appears to be a similar gas which has come under my notice, and if members of the mining profession would record their observations of the occurrence of this gas it might be found to be of more frequent occurrence in metal mines than Mr. Steidler infers. Should the description of the gas occurrence be accompanied by a short description of the geology of the district in which it is found, the accumulation of such information would undoubtedly lead to important results in the elucidation of the complex problem of ore genesis.

The first time that I noticed an accumulation of an inert gas lighter than air (other than that found in workings in recent lava-flows in which the oxygen of the air had been removed by chemical combination with the wall-rocks) was in the Brown Bear mine, Trinity county, California, during the fall of 1914. The locus of the gas accumulation was a blind raise from a prospect-adit driven into the hill on the east side of the gulch in which the old Brown Bear mill had stood and a short distance farther up the gulch. The line of demarcation between the inert gas in the raise and the ordinary air in the adit was sharp. The raising of the candle an inch above the point at which the gas was encountered was sufficient to extinguish it. This raise was full of the gas right down to the bottom of the timbers in the roof of the adit. I was told that this same gas was found in some of the raises from the main adit, but this I did not verify, although I was in some of them, but not to their tops. The Bragdon formation, of Carboniferous age, is the only sedimentary rock in the district. This unconformably (?) overlies a greenstone ('meta-diabase' of Diller), which has been assigned to the Devonian. These two formations have been faulted and intruded by dikes of a granitic texture, apparently apophyses of the grano-diorite mass a mile or two to the south, which is of supposedly Jurassic age. The ore deposits were formed subsequent to the intrusion of the dikes, but their exact age is uncertain and may be as late as the Pliocene, though probably of Miocene age.

The other occurrence of the inert gas observed was in the Cliff mine on the north shore of Port Valdez about nine miles west of Valdez, Alaska. It occurred in the tops of two blind raises, mostly above the portion of the raise where it was divided into a ladder-way and a rock-chute. The line of separation between the gas and air was not definite. There was usually several feet of a zone in which a mixture of the gas and air took place which was indicated by the dimming of the candle-flame. On further advance the flame was extinguished. There is but one geologic formation in the district—the Valdez formation—a metamorphosed series of Paleozoic (?) sediments which originally were slates and sandstones, but which now have a predominantly schistose structure. No igneous rocks occur near the mine. The nearest rocks of that type are some dikes near the mouth of Mineral creek, about five miles east. There are like intrusions to the west at about the same distance. The deposition of the gold took place previous to the movement that slickensided the vein. The striation from this movement is horizontal or nearly so, and records what appears to be the last movement of the rocks, of any magnitude, along the vein. However, the region is subject to seismic disturbances, and earthquakes of considerable magnitude are not infrequent.

The Bragdon formation and the Valdez formation, especially the latter, are composed of rocks that have reached chemical equilibrium, at least to the extent that they do not combine with the oxygen of the air with which they come in contact, and thus do not deplete the air of its oxygen content. In the Cliff mine between the two raises in which the inert gas occurs, there are five other raises penetrating the same character of formation and these are as favorably situated for the accumulation of the gas as the two in which it occurs, but they are entirely free from it. Many other raises and tops of stopes in this mine are also as well situated for gas accumulation as regards lack of ventilation, and if the rocks were absorbing the oxygen from the air they would be reservoirs filled with the gas; but this is not the case.

That this gas is exuding from a deep-seated source at certain zones from the rocks into which the mine-workings have penetrated is borne out by the field evidence, and my observations lead me to believe that it is one of the products of magmatism.

JACOB W. YOUNG.

Oakland, April 7.

Chemical Preparedness

California is in more than one way a treasure house for the nation. Fruits, vegetables, and grain grow in abundance in our fertile valleys. In the mountains of the State there are hidden rare minerals—besides gold, copper, and silver—that are able to yield some of the metals most needed in the iron and steel industries. With true Western lavishness we have skimmed the cream and let much of the wealth of the State go to waste. The chemists are preparing to stop this waste. They are preparing to find means by which wastes can be utilized and made valuable. A complete survey of the State's chemical resources is being carried out by the American Chemical Society; and in conjunction with this survey, the chemists have taken an active interest in a bill presented to the legislature to provide for the mobilization of the chemical resources of California for the purpose of State and National defense, to encourage the development of chemical industries, and to make an appropriation therefor.

This Bureau of Chemical Research would be associated with the University of California, just as the Bureau of Agriculture is doing excellent work through its close affiliation with the University. Those that are acquainted with the chemical conditions appreciate the big problems that confront them. For example:

Gold extraction in the mines today is severely hampered and in many cases stopped by a lack of cyanide. The citrus growers are suffering for the want of the same chemical, which is used in fumigating their orchards. The Bureau could help to correct this deficiency. Enormous quantities of agricultural waste from the farms are disregarded, although they contain elements from which valuable substances, such as alcohol, oil, and fertilizers, can be derived. The wood-waste from the large lumber operations in the State, constituting in some places a fire menace to the adjacent timber-stands, contains turpentine, alcohol, and other chemicals, as well as charcoal, each of them products of vital importance to industrial development.

These are matters of State wealth, as well as National preparedness, which the State Bureau of Chemical Research will be eminently fitted to investigate.

The best means by which our iron ores could be made available would be studied. Our National, as well as State, defense depends on the readily available supply of iron. Together with the charcoal produced from wood-waste, hydro-electric power obtained in the mountains, and iron ore, we might become independent of the world for our iron needs.

In the proposed bill is a special proviso made by which the activities of the Bureau will in no way interfere with the private practice of chemists of all descriptions. No employee shall engage in any private practice or receive any remuneration for work, except his salary from the said Bureau.

The local section of the American Chemical Society passed a resolution at a recent meeting urging the passage of this bill and also that a bill be presented before the legislature to protect the platinum supply of the country. Platinum is used extensively in the chemical arts and is also used in the jewelry trade. This bill would prevent, during this crisis, the use and sale of platinum in jewelry. Our national preparedness is dependent to a great extent on the available supply of platinum, since it is essential in the manufacture of some of the ingredients needed in every pound of explosives used on the battle-field.

Katanga Copper

A huge leaching plant and an electrolytic refinery are to be built as rapidly as possible for the Union Minière du Haut-Katanga at Elizabethville in the Belgian Congo. The plans are now being drawn in New York by H. Y. Eagle, S. Ward Haas, and P. E. Weldy under the supervision of Archer E. Wheeler, the consulting engineer for the company. All of the above engineers were formerly with the Anaconda Copper Mining Co., Mr. Wheeler having been superintendent of the Boston & Montana reduction works at Great Falls before being called several years ago to the managership of the Union Minière. The designing of the projected plant will require about six months, so that the actual construction cannot well be started for more than a year. The plans include the development of water-power. Mr. Wheeler has been conducting experiments on the leaching of the Katanga ores since his status was changed from that of manager to consulting engineer in 1914. The capacity of the plant will be about 110,000,000 lb. copper per annum. The original reduction plant consisted of 5 blast-furnaces, to which two more were added, giving a total capacity of about 1,000 tons of ore daily, the output of bar-copper for 1915 having been 31,450,000 lb. The ores are oxidized, and in order to introduce leaching methods it will be necessary to bring sulphide ores from other districts in order to make the needed sulphuric acid. Before the outbreak of the War the developed tonnage of the Katanga deposits was reported to be 6,026,500 tons, of which one-fifth averaged 15% and the remainder 7% copper. The probable ore, down to water-level, was estimated at 40,000,000 tons, with an indicated copper content of 8%. The mines are in a well defined copper belt 200 miles in length, on which over 100 distinct deposits of copper ore are known to exist.

At the Lonely Reef mine, in Rhodesia, hand-dressed felsitic rhyolite pebbles were tried as a substitute for Danish beach-pebbles, and the rhyolite pebbles were found to give a much higher grinding efficiency than the Danish pebbles. The rhyolite rocks were dressed by natives, and cost, ready for use, $5 per ton. Rhyolite suitable for this purpose should be firm and dense, with little tendency to break up into angular fragments. All rhyolite therefore is not suited to use for grinding in pebble-mills.

Mining Engineers and Belgian Relief

During this war the work of the mining engineer has received recognition on more than one battle-front, notably the tunneling corps of the British army. In the underground excavations leading to the planting and explosion of mines we are reminded of the fact that the word 'mine' among the Romans had a military significance before it had an industrial meaning. The word 'minatory' preserves that sense. Several members of our profession have lost their lives in military mining and many more have distinguished themselves. Among them we may mention Mr. Ralph Stokes, now a major, who enlisted in the Royal Engineers and then won a commission, rapid promotion, and the military medal. Another is Mr. Gelasio Caetani, serving with the Italian engineer corps, who is famous among his countrymen for the Col di Lana affair, in which he exploded a mine so successfully as to destroy many of the enemy and win an important position for his own side. But the object of this writing is to dwell not on the destruction of life in warfare, but to pay tribute to the saving of innocent lives by the organized effort of mining engineers in Belgium and France. We publish photographs of three men conspicuous in the work of the Commission for Relief in Belgium. The portraits will gladden the eyes of many of our readers. Mr. H. C. Hoover has won enduring fame by his big-mindedness, his executive ability, and his beneficence, all of which were applied to mitigating one of the world's worst tragedies. Born in Iowa only 43 years ago, he graduated in mining engineering in 1895 from Stanford University, of which he is now a trustee. Alert, energetic, and perspicacious he achieved prominence as a mining engineer when in his early twenties, while a member of the staff of Bewick, Moreing & Co., in Western Australia. He became a partner in the firm in 1902, and remained in partnership until 1908, doing notable service in quickening the intelligent exploitation of mines in Australia. In 1899 he was chief engineer to the Chinese Imperial Bureau of Mines and took part in the defence of Tientsin during the Boxer disturbances a year later. At the time of the invasion of Belgium by the German army he was a mine operator in London, acting as managing director or chairman of a number of important British mining companies in Australia, Burma, Siberia, the Yukon, and South Africa. He occupied an enviable position, being not only a rich man and an enterprising capitalist, but the leader of the American colony in London and always honorably prominent in Anglo-American affairs. When the outbreak of war brought hardship to Americans traveling in Europe, he organized a Refugee Committee that proved of inestimable service to thousands of stranded people. In this work he was aided by a number of other American engineers, among whom Edgar Rickard, John Beaver White, John L. Hoffmann, and M. K. Shaler may be mentioned. Then came the Belgian horror. The pitiable plight of a brave people, invaded without excuse and despoiled without compunction, appealed to him. He proceeded at once to do what he could to help them and soon created a wonderfully competent organization, the Commission for Relief in Belgium. How great a service he performed the world now knows,

H. C. HOOVER

but it is not known to the general public how intensely he felt the tragedy and how whole-heartedly he devoted his time, ability, and money to a great benefaction. The success of the work speaks for itself; it is due in the first place, of course, to the fine spirit that prompted the effort, but it is owing in large measure to the experience he had obtained while managing large mining operations from a distant base and among diverse peoples. Mr. W. L. Honnold, the director in America, joined the Relief Commission at the conclusion of a successful career in South Africa, where he had been 13 years an engineer and manager of big mining enterprises, notably the Brakpan. He was about to take a holiday when the call

came to work for the unfortunate Belgians. He went to Belgium and then had charge of the London office before taking charge of the New York office of the Commission. Mr. Honnold is a graduate of the Michigan College of Mines and practised as a mining engineer in California and Colorado before going to the Transvaal. Mr. Edgar Rickard is a mining engineer also, having graduated from the University of California, and was manager of the Triunfo mine in Mexican California for seven years before becoming business manager of the MINING AND SCIENTIFIC PRESS. When the War began he was business manager of *The Mining Magazine* in London. He co-operated loyally with Mr. Hoover from the first in his work for American refugees and the Belgian people. He served as an honorary secretary of the Commission in London and is now assistant-director in New York. The French representative of the Commission is Mr. Louis Chevrillon, another mining engineer well known in Mexico and in Colorado. Just now the work of the C. R. B. is particularly difficult owing to the withdrawal of the American staff in Belgium and the indiscriminate destruction of shipping, not even food-ships of the Commission being spared by the submarines of our unscrupulous enemy; but it cannot be emphasized too much that the work of the Commission is being continued loyally and efficiently by its Dutch and Spanish friends under Mr. Hoover's direction. What the effect of American participation in the great conflict will be on the fortunes of the Commission is not yet known; it is to be hoped that the United States government will grant an adequate subsidy, so that American financial assistance may compensate, however inadequately, for the withdrawal of the American staff—whose ability, much more than money, has been our gift to Belgium. Of the financial contributions, so far, the less said the better. It is nothing to be proud of. Nevertheless the C. R. B. has been an American undertaking, splendidly carried out, and it should continue to receive material support. Meanwhile the ability shown by Mr. Hoover and his co-adjutors had commanded such respect that he has been asked by the National Defense Council to become Chairman of a Food Bureau in the United States. This new and important duty he has agreed to undertake and we have no doubt but that he will be free to command the services of the engineering profession in this country in his national task, but if he voluntarily surrenders personal control of his great work in Belgium and France in order to assume this new responsibility, our Government should at least see to it that sufficient funds are set aside, out of the big bond issue, for taking care of the benefaction to which Mr. Hoover has devoted himself for the last three years.

W. L. HONNOLD

EDGAR RICKARD

Methods of Mining Big Orebodies—II

By ROBERT A. KINZIE

Second Method. This method of mining is applicable to stopes in meta-gabbro when the ground has been somewhat faulted and crushed or in mixed meta-gabbro and slate. It is particularly adaptable to the ground in the western portion of the ore zone. Fig. 3, 4, 5, and 6 illustrate in a general way the method to be described.

The orebody is divided into blocks, with levels at intervals of 200 ft. Each level is connected with a ventilating-shaft and ore-way placed in the foot-wall ground, as described under the first method.

A level is started by driving a cross-cut through the orebody from 'foot' to hanging wall. Drifts are then run in opposite directions from the cross-cut. One drift is run in the foot-wall waste-rock, parallel with and about 20 ft. from the foot-wall; another drift is driven in the hanging-wall waste-rock, parallel with and about 20 ft. from the hanging wall. These drifts are then connected by cross-cuts driven at right angles to the strike and spaced 70 ft. centre to centre. As the cross-cuts are run, chute-raises are put up to the level of the proposed floor of the stopes from both sides of the cross-cuts.

The chute-raises alternate on each side of the cross-cuts so that they have a spacing of 50 ft. on each side of the drift or a final spacing between chutes of 25 ft. At a distance of 25 ft. above the level and over the level cross-cuts, stopes are cut out 30 ft. wide. The length of the stope being equal to the width of the orebody.

Between the stopes, pillars 40 ft. wide are left. The bulldozing-chambers are cut out in the stope-pillars, spaced 50 ft. on centres along the side of the stope. These bulldozing-chambers are cut much smaller than in the First Method so that they will not unduly weaken the pillars.

The 30-ft. stopes are carried up to and connected with the stopes on the next higher level in the manner described previously.

The ore in the 40-ft. pillars is removed in two ways. First, the alternate or stoped pillars, namely, No. 3 and 5, etc. (Fig. 3 and 4), the odd-numbered pillars are drilled and blasted down gradually as the broken ore in the stopes is drawn. This work is done from the man-way cross-cuts previously driven from the foot-wall manway-raises through the pillars. This work is started from the top man-way cross-cut at the hanging wall where the pillar is cut free. (See Fig. 5 and 6). The work then proceeds retreating, drilling up, down, and on each side, and blasting the ore so that it will mix with the broken ore in the shrinkage-stopes. The machine-drills and men are always in the man-way cross-cuts, protected from the falling ground. When work on the top man-way cross-cut has proceeded a sufficient distance, the second is started, and so on until the ore in the pillar is removed.

After the odd-numbered, or stoped, pillars have been removed to within 15 ft. of the back of the intermediate level and all the ore has been drawn, the work of removing the ore in the even-numbered pillars is started.

This work can be done in a number of ways, depending on the character of the ground. If the ore in the pillars has been shattered or crushed, it can be reclaimed by blasting out the bottom of the intermediates and allowing the pillar to cave. The ore is drawn out through the chutes in the bulldozing-chambers and shrinkage-stopes. If the ground will not cave, it may be necessary to either carry up a narrow stope through the middle of the pillar or shatter it by placing heavy blasts in raises run from the intermediate cross-cut to various points in the pillar, thus weakening the pillar and causing it to cave.

When using this system, it is necessary to begin removing the pillars at the outer end of the top level and work in and down, although development and stoping may begin anywhere. It is also of prime importance that the drawing of the broken ore be so regulated that its surface will be fairly even for any particular section of the stope. In other words, the drawing of broken ore starts from the chutes on the hanging-wall side and proceeds in regular order from chute to chute until the foot-wall is reached. The exact number of cars of ore to be drawn from the different chutes is determined from the stope-maps and the strict enforcement of this rule will prevent the loss of ore by reason of its becoming mixed with waste-rock.

As the stopes are emptied of broken ore and the pillars removed, the waste-rock will cave from the 'foot' and hanging wall. This material forms a mattress on the top of the broken ore and follows down as the broken ore is removed.

Since the cross-cuts are driven under one edge of the stopes, the chute-raises on one side hole through under the centre of the stope and on the other side into the bulldozing-chambers, which are placed in the pillars.

Manway-raises connecting the levels are put up from both the 'foot' and hanging-wall drifts opposite the centre of the stope-pillars. The manway-raises from the foot-wall drift are put up opposite the odd-numbered pillars and those from the hanging-wall drift opposite the even-numbered pillars.

At the first intermediate level, 25 ft. above the main level, the raises are connected with the 'foot' and hanging wall by cross-cuts driven through the centre of the stope-pillars. From these cross-cuts, short drifts are

run to connect with the back of the bulldozing-chambers, or to the adjoining stope. (See Fig. 3.) At intervals of 30 ft. in height, cross-cuts, called man-way cross-cuts, are run in the odd-numbered pillars from 'foot' to hanging wall. These cross-cuts are connected with the stopes by short drifts, for the purposes of communication and ventilation, as may be found necessary.

Third Method. This has been proposed for stoping blocks of ground composed in part of crushed black graphitic slate and in part of mixed schist and meta-gabbro or blocky meta-gabbro or schist.

It is proposed to start from a level at a depth of over 1000 ft. below the surface and under-cut blocks of ground 250 ft. wide and of a length corresponding to the width of the ore-zone (500 to 800 ft.); then by means of raises and short powder-drifts, similar to those used for blank-blasting in quarries, to blast down part of the back of the stope into a chamber previously excavated and cause the ore in the roof of the stope thus formed to cave. The ore broken and caved by the above method is to be drawn off through chutes on the main haulage-level, and the large slabs broken into pieces that will pass through the chutes, in the bulldozing-chambers placed along the sides and the foot-wall end of the stopes.

Fig. 7 is a projection at right angles to the strike of the vein and shows the most important features of this method of stoping. The orebody is divided into blocks

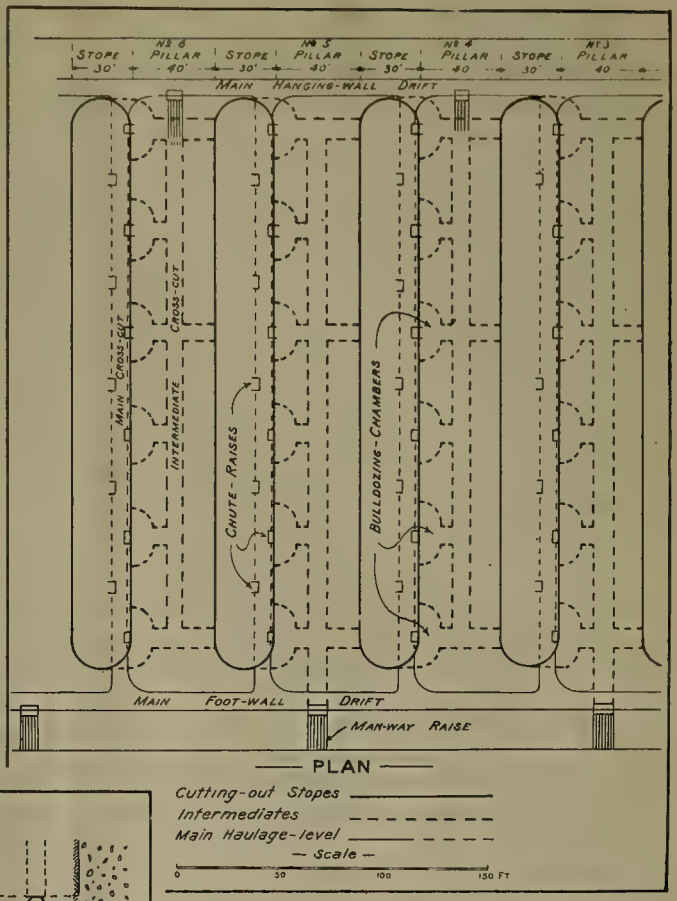


Fig. 3.

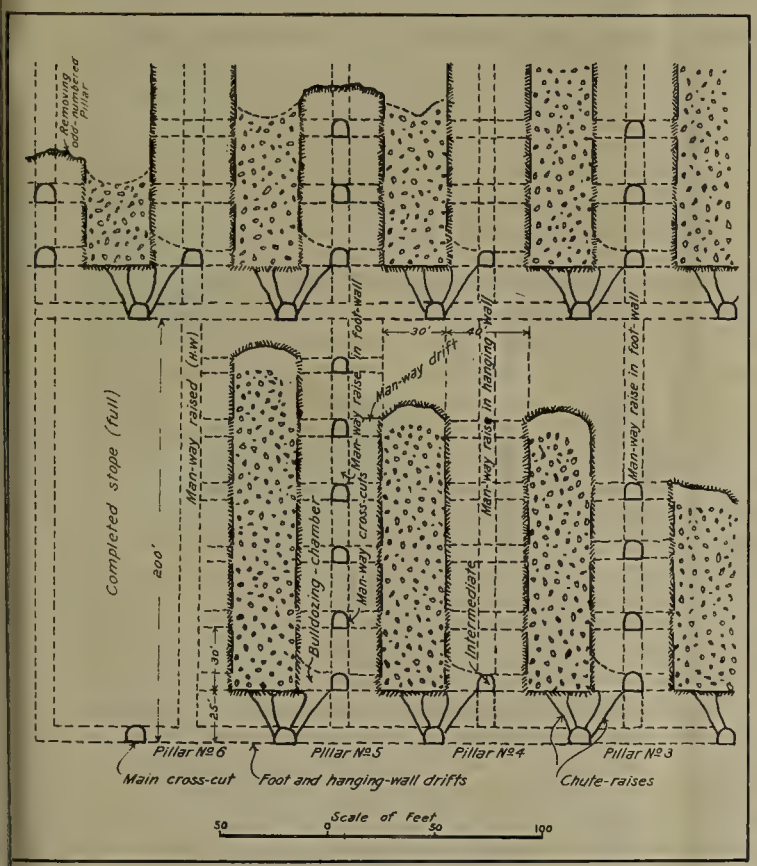


Fig. 4.

with level-intervals of 200 ft. Each level is connected with a main ventilating-raise, placed in the foot-wall ground and driven at an angle parallel with the dip of the foot-wall of the orebody.

The plan of opening the main haulage-level follows closely that described under the First Method, with the exception that the chute-raises will be closer together, for the reason that is is planned to draw all the ore broken in a number of the levels above the main haulage-level through one set of chutes and bulldozing-chambers on the main haulage-level. When the chute-raises have been completed and the chutes built, the sill-floor of the stope is cut out over the entire area of the proposed stope. The height of the first cut will change with the character of the ground, varying from 7 to 60 ft. Since the bulldozing-chambers are to be placed along both sides and the foot-wall end of the stope, it seems that it will be necessary to either carry up the stopes by ordinary shrinkage methods to a height of 50 or 60 ft. or cut out the sides and foot-wall end of the stope to a similar height, leaving the centre of the stope low and unsupported.

After the stope has been cut out and the bulldozing-chambers completed it is proposed to put up a number of raises connecting the back of the stope with the bottom of the next higher level. At suitable intervals, varying from 20 to 30 ft., short stub or powder-drifts will be run from each stope-raise—these powder-drifts to vary from 10 to 30 ft. in length, depending on the character of the rock. The purpose of connecting the stope-raises with the next higher level is twofold: To furnish ventilation and to give access to the powder-drifts after stoping (bank-blasting) has been commenced.

The second period of stoping, namely, bank-blasting and caving, is started by drawing from the shrinkage portion of the stope as much of the broken ore as possible, thus leaving a large open chamber. Explosives are then lowered from the level above through the various stope-raises to the lowest row of powder-drifts. The explosives are then to be loaded into the powder-drifts, tamped and connected with electric detonators in the manner common to quarry bank-blasting. After the row of powder-drifts has been blasted and a suitable amount of the spoil drawn, the other rows of powder-drifts are handled successively in the same manner until the back of the stope reaches the next higher level.

It is to be observed that, after the second stage of stoping has once been started, the stopes will be impassable on account of the ragged and dangerous character of the roof and the only method of breaking pieces of rock too large to pass through the chutes is to have them flow by gravity to the bulldozing-chambers, where they can be block-holed or bulldozed. The angle at which broken ore in a stope will cease to flow depends to a great degree on two factors: first, the amount of moisture present and the amount of packing the broken ore has been subjected to, and second, the size, shape, and character of the pieces broken down from the roof. If the rock is dry and of such a character that it will crush into small uniform pieces, it will flow at a much flatter angle than a mass of broken rock made up of soft fine and large irregular slabs of hard tough rock. When shrinkage or caving methods are applied to wide stopes, much trouble is experienced in causing the broken ore to flow freely to the chutes and, where it is impossible to put men in the stope to loosen the packed ore by 'picking in' or blasting, there is often a loss of large quantities of broken ore or at least a delay in its recovery until the stopes from the next lower level are carried up and completed.

Fourth Method. This is applicable to orebodies in black slate or in schistose meta-gabbro, similar to those in the hanging-wall portion of the Perseverance orebody above the No. 5 level and elsewhere in the Juneau ore-zone.

Ore of this character drills better than that in fissured meta-gabbro and has a tendency to break in long thin slabs well beyond the bottom of the holes. The broken ore, after exposure to air, will crumble and on its passage through the stopes to the chutes and bulldozing-chambers a large proportion of the larger pieces will be so reduced in size that they will pass through the chute-openings, thus materially reducing the cost of bulldozing and sledging.

When the orebody is first opened, it stands fairly well for a time sufficient to safely cut out the sill-floor, but after stoping is started it has a tendency to cave from the hanging wall, thus confining most of the machine-drilling to the foot-wall portion of the stope.

The following description presupposes that the preliminary development work, such as shafts, ore-ways, and ventilating-raises, has been completed and the main cross-cut on the level run through the orebody to be stoped.

Fig. 8 and 9 show, in some detail, the method of opening up a block of ore preparatory to stoping, and Fig. 10 shows the manner of cutting out a stope, back-stoping the ore and the relation of the bulldozing-chamber to the broken ore in the stope.

When opening up a level the first thing done is to drive a cross-cut from the main ventilating-shaft to and through the orebody to be stoped. If possible this cross-cut should unite with a manway-raise connecting at least two levels and driven in the foot-wall of the orebody to be stoped. At the point where the above cross-cut intersects the foot-wall, drifts are turned off in opposite directions and continued along the foot-wall to the limits of the orebody. At intervals of about 400 ft. manway-raises are put up along the foot-wall to the next higher level, and stub-drifts run as explained under the First Method.

The spacing of these manway-raises is controlled by the length of the proposed stopes, as the manway-raises are put up along the centre line of the stope-pillars. As the levels are extended, the chute-raises are put up 25 ft. centres on the foot-wall side of the drift, under the proposed bulldozing-chambers to a height of about 30 ft. If the orebody is over 50 ft. wide, it is convenient to put up a line of chute-raises from the hanging-wall side of the level so that they will intersect the floor of the proposed stope at points about midway between the foot and hanging walls. These chute-raises are used primarily for drawing off the broken ore during the cutting-out of the stope and in the early stages of the back stoping before the hanging-wall portion of the stope is high enough to permit the broken ore to flow to the bulldozing-chambers.

At a distance of 30 ft. above the level, intermediate drifts are run in the foot-wall waste parallel with and about 40 ft. from the orebody. They are connected to the bulldozing-chambers by two cross-cuts. The idea of two cross-cuts is to improve the ventilation and means of communication. On account of the draft being up through the bulldozing-chambers into the stope, the first bulldozing-chambers were cut out so that the intermediate drifts simply connected the ends of the chambers. This construction was changed to the one illustrated in Fig. 8 on account of a number of accidents caused by the broken ore hanging up in the stopes and leaving large open spaces. These open spaces, together

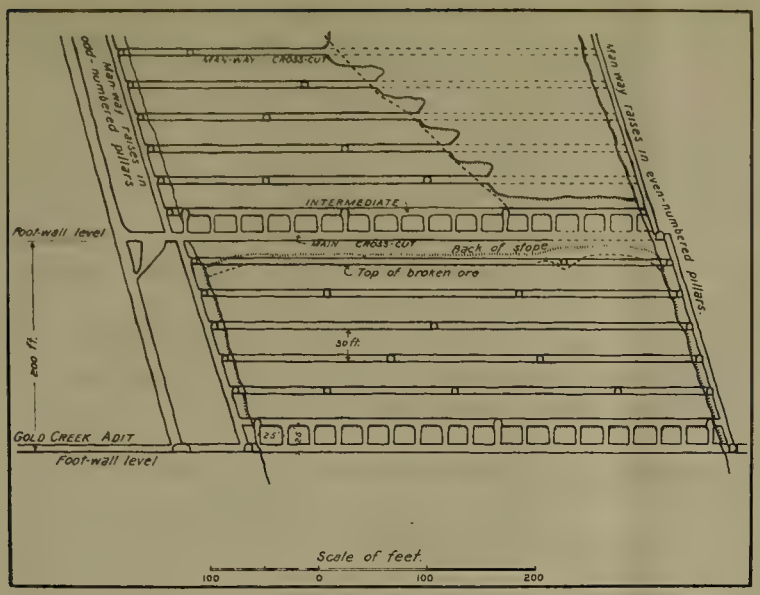


FIG. 5.

with the bulldozing-chambers, would be suddenly filled by a rush of broken ore when the 'hang up' lets go, thus not only subjecting the men working in the bulldozing-chambers to great personal danger, but often cutting off their means of ingress and egress by reason of the manways being filled with broken ore. The intermediate drifts are connected with the manway-raises by means of short cross-cuts or inclined raises.

The stopes are cut out as indicated in Fig. 10. It will be noted that on this sketch the bottom of the stopes has been cut out at an angle of 45°. In the past this has only been done in a few instances, the majority of the stopes being cut out with a horizontal floor. The objection to the 45° floor is that it leaves a large block of ore between the level and the bottom of the stope that will have to remain until the stopes from the next lower level reach it. However, with a 45° bottom, a large expense

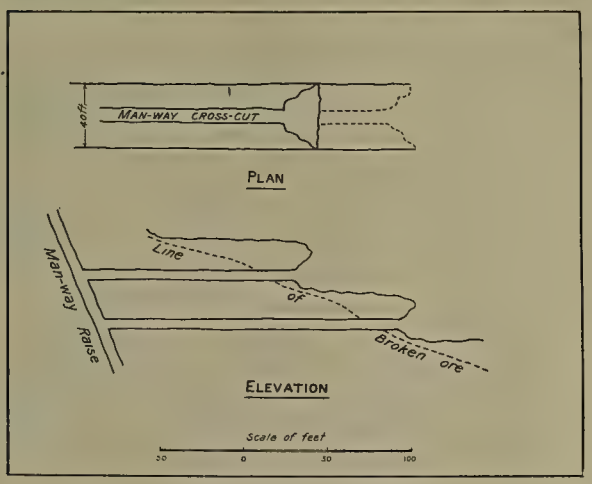


FIG. 6.

due to shoveling into chutes is avoided and, if the ground is heavy, the work of cutting out is much safer than with a flat floor.

If the ground stands well, it can be drilled from any point in the stope and the surface of the broken ore kept level, but if the ground shows a tendency to cave, the drilling must be confined to the foot-wall portion of the stope and the ore in the hanging-wall side allowed to cave after being cut loose from the foot-wall.

If the hanging-wall rock, which in many places is simply the limit of pay-ore toward the hanging-wall side, is such that excessive caving from it might be expected, the procedure differs from the above as follows:

To determine the limits of pay-ore toward the hanging wall, cross-cuts at suitable intervals (usually 100 ft.) are started from the tops of the foot-wall chute-raises and driven upward and toward the hanging wall at an angle of about 50°. As these cross-cuts progress, they are carefully sampled and the limits of the ore

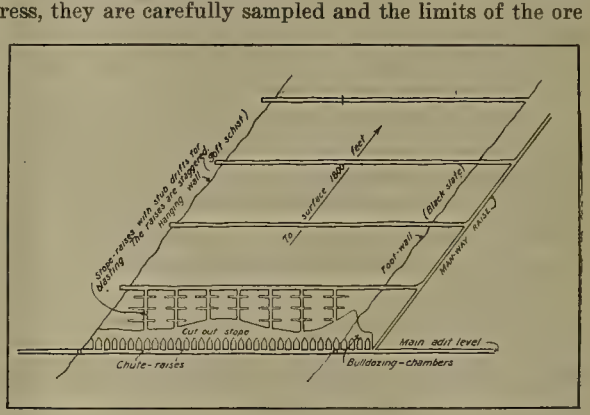


FIG. 7.

accurately determined. The bottoms of these cross-cuts are driven to correspond with the bottoms of the future stopes and the cutting out of the floors of the stopes is performed by simply drilling and blasting from the sides of the cross-cuts until they meet and form the floor of an open chamber.

The stope, however, is not cut out to the limits of pay-ore as determined from the stope cross-cuts, but a width of ore is left next to the hanging-wall side. The thickness of this ore varies according to the nature of the ground, from 10 to 30 ft. The object of leaving this layer is to prevent dilution of the stoped ore by waste caving from the hanging wall. All of the ore so left is not lost, for, in practice, most of it caves and becomes mixed with the stoped ore before the stope is drawn. It requires experience and an intimate knowledge of the mine to determine how wide this pillar should be. If it is

not wide enough, the caving will extend into the waste-rock of the hanging wall and will become mixed with the broken ore; if the pillar is left too wide, ore will be left as the stope progresses and will be lost.

The black slate and schistose meta-gabbro drill well and permit of the use of one-man hammer-drills. Long holes can be drilled and, since the average footage per machine-drill shift is about 80 ft., the tons broken per drill-shift are correspondingly high.

As little bulldozing and sledging as possible is done in the stopes, but the large slabs and pieces of broken ore are allowed to work down to the bulldozing-chambers, where they can be safely and economically handled.

When the stope reaches the next higher level, it is continued until the block of ore left between the level and the bottom of the stope is extracted. The connection between the top of one stope and the bottom of the next higher one is made in practically the same manner as in the First Method.

About 35% of the broken ore can be drawn as the work progresses and this ore, as well as the broken ore contained in the finished stope, is drawn through chute-raises equipped with 6-ft. arc-gates, loaded into cars and trammed to the transfer-raise to be again loaded into cars and hauled to the coarse-crushing plant at the mill.

Tramming. In the majority of mines, where large tonnages are handled, the cost of tramming includes the loading of the broken ore into cars, from chutes or otherwise, hauling the ore or waste to the shaft-pockets or transfer-raises, dumping the loaded cars, and returning the empty cars to the point of loading. It is, therefore, apparent that the methods and means employed for each stage of the operation have a direct bearing on the amount of material that can be handled in a given time and also on the final cost of the operation.

Chutes. In small mines, where the ore is blasted down on timbered floors and there broken into comparatively small pieces, the design of the chute is not of great importance and the ordinary board-chute is satisfactory, both from the standpoint of efficiency and cost. In the large low-grade mines of the Juneau belt, where the ore is broken in chambers devoid of timber and where every effort is devoted to the quick and cheap delivery of enormous tonnages of rock, the design of the chute becomes of prime importance.

The coarse-crushing plants now built have machines with openings large enough to receive pieces of rock 36 by 48 inches. It is, therefore, apparent that the chutes will have to be so designed that they will handle this material quickly and continuously.

For the diorite ores of Douglas island, where the broken rock is dry and has a large proportion of coarse material, the so called finger-chute is in use and has been found to answer all requirements. Experience has shown that when the number of fingers in a chute is increased to more than six, there is a tendency for the outside ones to lap over the side-boards and jam. This limits the width of the chute to 42 inches, allowing pieces of rock 24 by 36 in. to be handled with ease. With the introduction of larger crushers and the increased use of transfer-chutes, where it is necessary to handle large tonnages in a limited time, the finger-chute is inadequate and has to a large extent been superseded by an arc chute-gate, both on Douglas island and in the mines on the mainland. In the Perseverance mine, of the Alaska Gold Mines Co., a small bulldozing-chamber with a grizzly-floor, made of 80-lb. rail, is placed immediately over the head block of the chute. This type of chute was originally used by G. T. Jackson, when superintendent of the Perseverance mine.

The three most important features of this type of chute-gate are:

1. Simplicity of operation, one man only being required to operate the chute.
2. Capacity.
3. Freedom from overflow or spilling of fine on the track.

The chute is operated by one man standing on the platform. The weight of the arc-gate is counter-balanced by a counter-weight, thus leaving only the friction of the broken rock to be overcome when opening or shutting the gate, which operation is performed by lowering or raising the handle.

At the transfer-chutes in the Treadwell mine, the arc-gates are eight feet long. A train of 10-ton cars is loaded by hauling the train slowly underneath the opening of the chute, it being unnecessary to stop the train and spot each car as is the case when using the finger-chute.

It will be noticed that the chute is so designed that either the ¼-in. steel lining or the first layer of 2-in. plank forming the floor of the chute is practically in contact with the inside of the arc-gate, whether it is open or shut. This prevents the fine material sifting out and falling on the tracks and also prevents the jamming of the gate by reason of pieces of rock becoming wedged between the lining of the chute and the arc-gate. Since the chute is closed by raising the gate through the stream of broken ore, it will stop the flow quickly and cleanly even though very coarse material is being handled.

When operating either the common board-chute or the finger-chute, a great many accidents occur to chute-men by reason of rocks bounding from the chute or falling from the cars being loaded. With both of the above types, the chute-men when loading cars work either directly in front of or slightly to one side of the chute-opening and in line with any material falling from it. When operating the arc-gate they stand on a platform above the cars and are thus protected from objects falling from the chute or from cars.

Cars. In mines where there is a big tonnage to be handled, there is a marked tendency to use cars of large capacity. This is particularly true in the Juneau district, where, since most of the development work is in ore that stands well, the drifts and cross-cuts are unusually large.

For development work, a specially designed low-

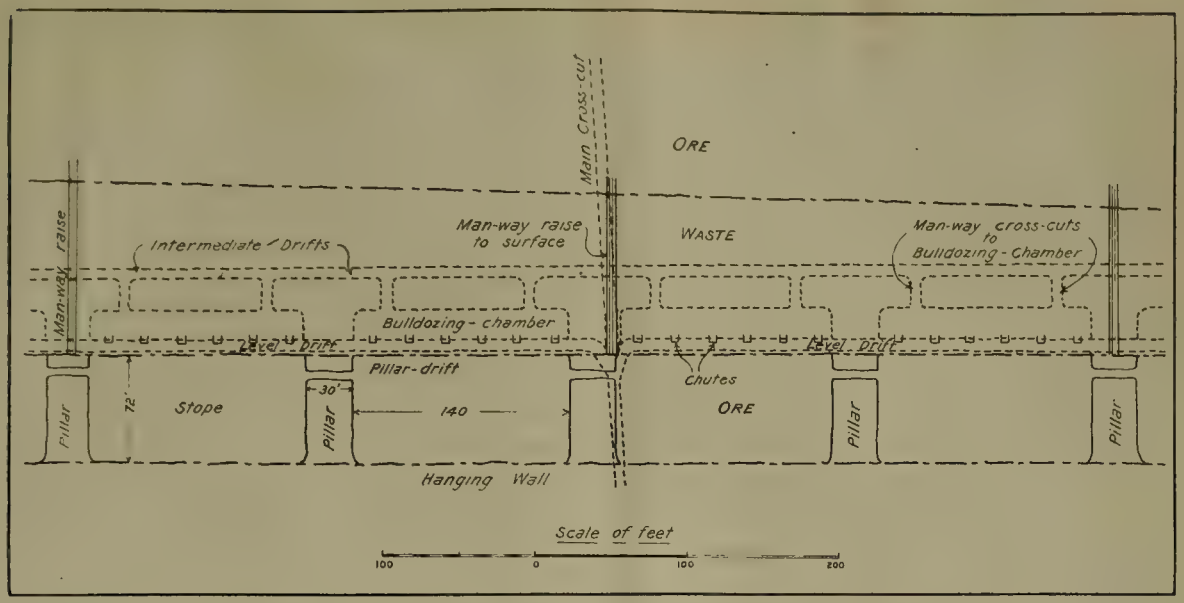


FIG. 8.

shoveling car, holding about two tons, is used. If the work is near the 'ore' or waste-way, the cars are trammed and dumped by the shovelers; if the working-place is at a distance from the dumping-place, the cars are trammed to the nearest side-track and then left to be collected and hauled to the dumping-place by a special crew. (Fig. 12 shows the type of car now being used on Douglas island and in some of the mainland mines). Since these cars hold from 10 to 12 tons of ore, the tramming is done by mechanical haulage. The type of car illustrated is used either singly or in trains to haul the ore from the stope-chutes to the ore-pockets, and they have shown a marked saving per ton of ore trammed over the two and three-ton cars heretofore used.

The first cost of this type of side-dump car is much higher than a car of equal capacity designed to be dumped by means of a tipple, but when the first cost of the tipple, including driving mechanism and power-connections, and its cost of operation are taken into consideration, it will work out the cheapest per ton of rock trammed. Since the opening is practically the entire side of the car and the gable-ends are steep enough to prevent the fine hanging up, these cars are capable of handling both fine and coarse material.

When these cars are used in trains, a sheet-steel apron is attached to one car and extended to a sufficient distance to overlap the top of the adjoining car preventing rock from falling between the cars and blocking the track when the train is being loaded.

In the Perseverance mine of the Alaska Gold Mines Co. the so-called Granby system of tramming is used. The cars have side-openings and are self-dumping. The capacity of the cars is only limited by the size of the underground openings and the structural difficulties and cost of building large cars. The most economical size of car for underground tramming is about 100 cu. ft. The cars are made up in trains of from six to ten cars and are emptied automatically by hauling the train past a simple stationary dumping device. It is not necessary to uncouple the locomotive from the train nor is there any attendance required. The

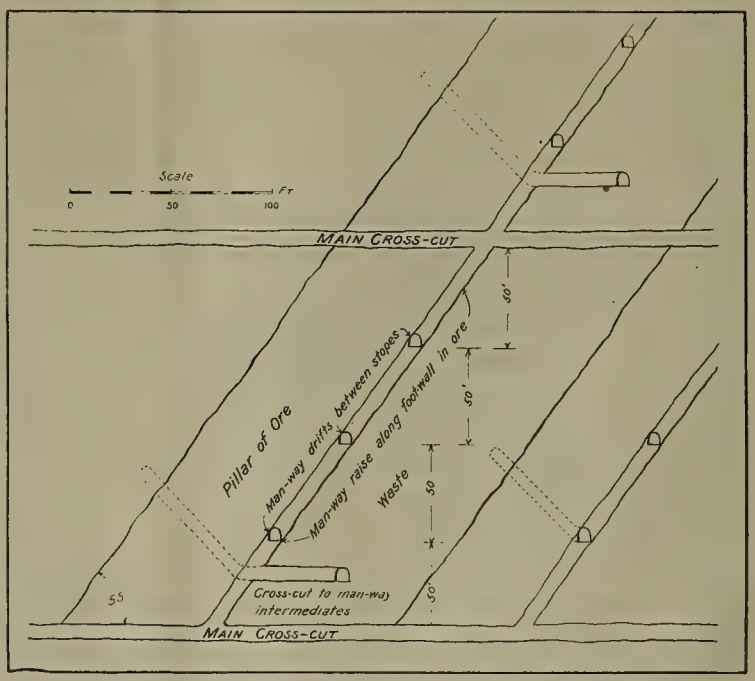


FIG. 9.

wear and tear on the cars is small and the system is more economical and satisfactory than any other so far used or suggested for the large low-grade mines adjacent to Juneau.

HAULAGE. At the present time, there are five different methods of hauling cars underground.

1. Hand-tramming, where one or more men push the cars to and from the place of use.

2. Animals; both horses and mules are employed.

3. Endless rope; this method is used in the mines of the Treadwell group to increase the tonnage over that possible by means of men or draft-animals.

4. Storage-battery locomotives; the cars being gathered, either singly or in trains, and hauled to any desired point on the level.

5. Electric-trolley locomotives; the tramming is done by electric locomotives deriving their power by means of a trolley from bare wire strung throughout the route to be traversed.

The advantages and disadvantages of the first three types of tramming are well known. Where the distances are short, the question of capacity determines the choice of methods, the cost per ton being practically the same where the method selected fits the job. To my mind, the most important item that has been contributed, in the last few years, toward the reduction of tramming-costs has been the perfecting and introduction of the storage-battery locomotive. These engines, for underground service, are now supplied by a number of manufacturers in sizes ranging from 3 to 10 tons, and their continuity of service and cost of operation have been most satisfactory. I feel confident that it will be but a comparatively short time before they will have supplanted all other methods of tramming in large mines where the distances are not too great. Where the hauls are long, the trolley-locomotive still holds its place, but for a variety of reasons (such as safety, mobility, etc.) the storage-battery locomotive will take the place of the trolley-locomotive.

If continuous service is required of the storage-battery locomotive, duplicate sets of batteries are supplied. These are furnished with racks that hold the necessary cells for the locomotive and they are so arranged that the discharged cells can be quickly removed and charged cells substituted. The charging-stations are usually placed at or near the main ventilating-raise or shaft and do not require any additional labor or skilled attendance.

In a number of mines, gasoline-locomotives have been tried, but their performance has not been satisfactory. When the machines are new and the temperature not too low, they do fairly well, but they require careful handling and, if the ventilation is at all poor, they are dangerous on account of the noxious gases they generate.

SAMPLING AND ASSAYING. On Douglas island, where the ore is a homogeneous diorite and the gold-content in any particular part of the mine is evenly distributed, the determining of the value of the ore is a comparatively simple operation. The ore is usually sampled in five-foot sections by moiling a groove at right angles to the strike of the deposit, four inches wide by from one-half to one inch deep. All the material thus obtained is sent to the assay-office and ground to pass an 80-mesh screen. It is then cut down and assayed in the usual manner. This procedure gives results that will check. The gold-content of large blocks of ore, determined as above, agrees closely with the mill-returns plus tailing.

When we come to the large orebodies of mixed quartz, slate, and meta-gabbro on the mainland, the problem of determining their gold-content becomes difficult. In the first place, the ground is much broken and disturbed by slips and faults, making it necessary to take a great number of samples to determine the value of even small blocks of ore. The gold is coarse and is contained in the quartz lenses or stringers. In the slate orebodies the quartz stringers are fairly distinct, while in the meta-gabbro orebodies they vary from lenses 20 ft. wide, at their widest, to a stock-work of minute interlacing stringers. Where the quartz stringers are absent or sparsely distributed, whether in slate or meta-gabbro, the rock is not rich enough to be mined.

As a result of long experience with such ores and after trying many methods of sampling and assaying with many thousand samples, I have come to the conclusion that the ordinary methods of hand-sampling do not give results that can be depended upon when estimating the gold-content of any large mass of ore. The method of hand-sampling that has given the best results is the one proposed by W. W. Mein. This method has been checked by mill-tests and when the samples were carefully taken and the assaying properly done, they agreed within acceptable limits. The essential difference between this method of sampling and that employed in the Douglas island mines is that in place of the length of the sample-section being confined to a predetermined number of feet, its length is governed by the width of the particular stringer of quartz or band of rock to be sampled. If the width is more than five feet, a sufficient number of samples was taken to insure that no one sample would have a greater length than five feet. It often happens that a six-inch stringer of quartz assaying, say, $750 per ton would have ten feet of barren black slate on each side of it. If the ground were sampled in 5 or 10-ft. sections, the average obtained would be misleading. In the meta-gabbro ore a distinction is made between stringers over, say, three inches wide, and the mineralized meta-gabbro, they being sampled separately.

The most satisfactory method of determining the gold-content of the above ores is by the use of a test-mill capable of treating a comparatively large tonnage of ore. The material to be tested can be obtained by slabbing off a section, say, two feet thick, over the entire side or top of the level, depending on whether it is a cross-cut or drift, or the ore can be stoped from any desired portion of the mine.

The unreliability of hand-sampling has been fully recognized in the district, and, as a result, all of the mines that are now producing or being developed on a large scale have been or are now equipped with experi-

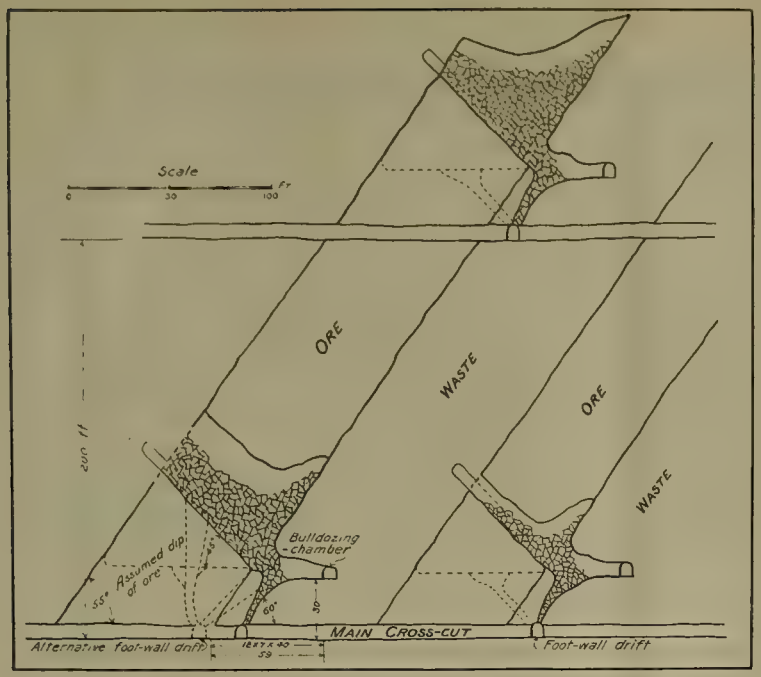


FIG. 10.

mental or sampling mills. The Alaska Gastineau and the Alaska Juneau companies have treated large tonnages of ore from different portions of their mines before the experimental mills were built preparatory to the construction of their permanent plants. A careful sampling, by means of a 5-stamp amalgamating and concentrating mill, was carried out at the Ebner mine. This work has been briefly described by Sidney Jennings, under whose direction it was performed. It was done with great care and attention to detail and I am satisfied that, if this method of determining the gold-content of the ore is adopted in the district, it will give accurate information as to the value of the various orebodies.

At the Perseverance mine a 100-stamp mill was first used to sample the ore from the mine and during its operation it treated about 300,000 tons of ore. This was the first time that a large tonnage of unsorted ore, from the mainland mines near Juneau, was thoroughly sampled. It was also in this mill that the first comprehensive re-grinding and concentrating tests were made. The result of this work was far-reaching, for when the Alaska Gold Mines Co. constructed the experimental mill in Sheep Creek basin, it differed from all the mills previously built in the district, free-gold amalgamation being eliminated and a straight concentration and re-grinding method substituted. It was the sampling data collected in the Sheep Creek experimental mill that determined the final flow-sheets for the large Alaska Gastineau and Juneau mills.

No matter how carefully the sample is taken, the final results will be worthless unless the assaying is done properly. To get assays that will check, it is necessary to grind the pulp so that it will all pass through at least a 150-mesh screen. On account of the coarse gold in the ore, close watch should be kept for 'metallics'; their value should be determined and added to that of the pulp in the usual way. The ore is not a difficult one to assay and I am sure that if the pulp to be assayed is ground fine enough, the assay results will check, and confidence as to the results will take the place of the uncertainty that has existed in the past.

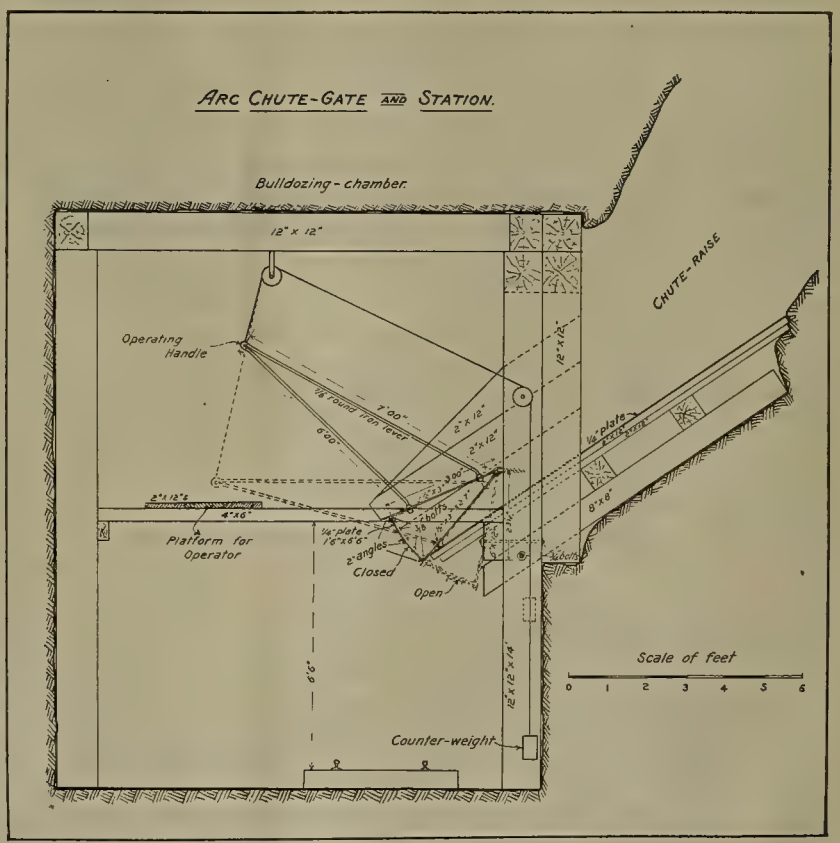


FIG. 11.

An Improved System of Classification

By JAMES M. HYDE

Flotation concentration, meritorious as that process has proved to be, is not a panacea for all of the troubles encountered in the treatment of ores. There may be some ores requiring such fine grinding to free their valuable constituents that flotation may be a logical single process for their treatment. Such ores do not appear to be common.

From the standpoint of the smelter it is highly desirable that a minimum amount of fine concentrate be made, as this product tends to make flue-dust, with corresponding furnace-losses. It may be necessary therefore for the smelters to pay less for the finest concentrates than they can afford to pay for coarser material of the same chemical analysis.

Many ores have their metalliferous constituents so distributed that without crushing finely a considerable proportion of gangue can be discarded. Tabling and jigging are cheaper methods of treating material of the sizes to which they are adapted than flotation is ever likely to be.

In the treatment of complex sulphides, where it is desirable to make different concentrates instead of one general sulphide concentrate, it is best that a minimum of fine be produced. By tables and jigs lead may be easily separated out from many ores as a high-grade concentrate, and where a supplementary process is needed for separating minerals of like specific gravity, as, for instance, pyrite and the copper minerals from zinc-blende, the best results either by electro-static or electro-magnetic separation are obtained in treating materials too coarse to be readily floated.

It is highly probable that selective flotation will some day be so perfectly worked out that by flotation concentration alone a mixed sulphide ore may be divided into fairly high-grade concentrates of two or even three classes. From an ore containing pyrite, chalcopyrite, blende, and galena it is probable that we shall soon be able to make, by selective flotation, a lead concentrate low in copper and zinc, a copper concentrate low in lead and zinc, and a zinc concentrate low in copper and lead.

Even when that ideal is accomplished we cannot expect flotation to become the sole means for concentrating such ores, as the reasons previously mentioned will still make it desirable to remove as much of the metalliferous minerals as possible in sizes too coarse for flotation, to throw away as much of the tailing as possible without fine grinding, and to send to the smelter a minimum amount of 'slime concentrate.'

The perfection of electro-chemical and hydro-metallurgical processes for recovering the several metals from concentrates may render it advisable to use flotation as a sole concentration method in the treatment of ores in the milling of which a combination of methods is now necessary, but at the present time, and probably for some time to come, the mill-man must look upon flotation as a valuable auxiliary process and adapt his operations to the end of making it serve his needs in the most efficient manner.

Ore-dressing had its beginning in crude operations, but it is gradually developing into a highly specialized art. Its perfection lies largely in the bringing of all of its operations under the most positive and intelligent control.

In introducing flotation concentration into mills that were built and in operation before the adoption of this process, the greatest obstacle I have had to overcome has been the difficulty of getting all of that part of the ore which it is desirable to treat by the new process gathered together and delivered to the flotation-machine at the right consistence.

The feed to the flotation-machine usually consists of the finest part of the ore resulting from the primary crushing operations and the re-ground middling or tailing from the jigs or tables. These products are derived from classification, jigging, and tabling operations, which, as a rule, produce a very dilute pulp.

The first mill in which I introduced flotation, the one at Basin, Montana, at that time rented and operated by the Butte & Superior Co. of Butte, was following the practice of jigging the whole of the ore after it had been crushed to pass through a 5-mm. screen without any preliminary classification. The launders ahead of the jigs were so flat that extra water had to be added to the pulp to keep it flowing. The jig-tailing was classified and the coarser portion was re-ground and again classified. The resultant products were divided between jigs, tables, and vanners for further treatment.

When the fine from the classifier-overflow and the tailing from the tables treating the finer sand and from the vanners were gathered together they formed a pulp containing over 50 parts of water to 1 part of ore. This pulp was thickened in cones and the overflow from these cones was found to carry into the tailing as high as 15% of the metal in the ore. The fine ore overflowing from the cones used to thicken the primary classifier-overflow contained a higher percentage of metal than was contained in the crude ore. These conditions obtained when the mill was treating 400 tons of ore per day, and using, if I remember correctly, 70 standard cones for pulp-thickening.

The ore being treated in this mill carried from 18 to

23% of zinc as sphalerite, 1 to 1½% of lead as galena, small amounts of pyrite, a few ounces of silver, and a little gold in a gangue consisting principally of quartz, rhodonite, rhodochrosite, and granite in which part of the feldspar was kaolinized.

The peculiar difficulties encountered in the treatment of this ore were due to the fact that the kaolinized feldspar made a slime that settled very slowly; the crushing necessary to bring the ore to 5 mm. size broke much of the sphalerite into sizes too fine to catch by tables or vanners; and when a commercial grade of concentrate was maintained the jig and table tailings contained much sphalerite that could only be released from the quartz in which it was enclosed by grinding to such a degree of fineness that the sphalerite thus broken free could not be efficiently recovered by tables or vanners.

In a mill built later to treat this same ore the dilution of the slime throughout the plant was less than in the old mill, but the same difficulty was experienced in getting all of the fine portion of the pulp gathered together and delivered to the flotation-machine in proper condition for treatment. Four large flat-bottomed thickening-tanks with rake-arms for gathering the settled slime to a central discharge were used in preparing the dilute classifier-overflow. Lime and ferrous sulphate were added as coagulants, but the dilution of the pulp was such that the total volume to be treated was so great that again it was found that as much as 15% of the valuable content of the ore would sometimes be carried to waste in the overflow from the pulp-thickeners. This was particularly exasperating as the flotation department could make high-grade concentrate and an excellent recovery from this material if delivered to it in proper condition.

The 'slime' portion of this ore was of an extremely slow-settling type, as shown by the fact that when a Callow cone was filled with the pulp and thrown out of

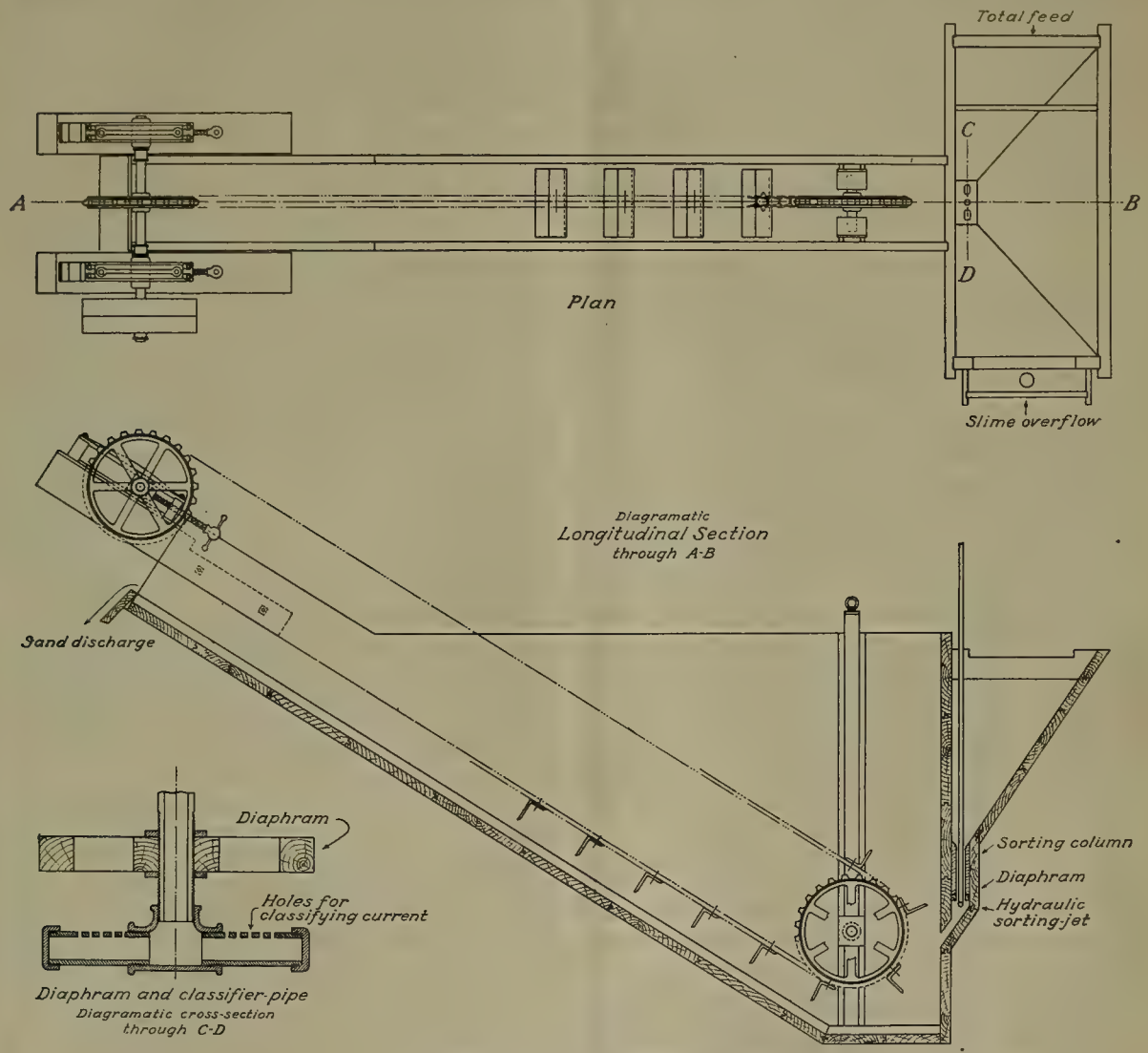


FIG. 1. DE-SLIMING MACHINE.

circuit and permitted to stand at rest for three hours, the whole pulp was still extremely opaque and the material in suspension still contained 14% of zinc. A large equipment of cones and flat-bottomed thickeners was installed before all of the flotation-feed could be put into proper condition for treatment.

The obvious deduction from a study of the behavior of this and similar ores was that the ideal way to overcome the difficulty of dealing with pulps too dilute for satisfactory treatment would be to avoid the production of them. Preventive rather than curative methods were indicated. I was led at that time to the belief that it should be possible to invent a thoroughly satisfactory system of classification, which would in one operation, immediately following each crushing, remove all of the material of a desired degree of fineness with an absolutely minimum dilution and then turn the sand over to a classifier, which would classify it and deliver a slimeless product to tables or jigs, so that a simple dewatering operation would prepare the table middling or tailing for re-grinding, and the water removed before re-grinding would be so free from valuable mineral that it could be thrown to waste, or returned to the mill water-supply.

The ordinary system of hydraulic classification permits such mixing of 'slime' with the sand from each spigot of a hydraulic classifier as to cause slime to be a constituent of the tailing of each of the machines treating the sand-sizes. The true 'slime' product of the hydraulic classifier is diluted with the hydraulic water added in each of the compartments, and carries therewith the bulk of the water contained in the pulp before classification, all combined into an excessively dilute pulp. My experience with drag-classifiers has proved them to be useful and logical as a means of removing much of the slime previous to other classification, but I have not found them sufficiently positive to remove the slime so completely that the back-water from the tables could be kept so free from valuable metal that it could be discarded without separation and thickening.

The most logical method of applying known physical principles to this problem seemed to be to combine hydraulic classification, in which only so much water would be added to the pulp as is necessary to keep in suspension all of the material desirable to retain in the slime-pulp, with a means for removing the sand from below the hydraulic column through which they have settled without setting up any downward current of water such as would tend to carry some slime along with the sand. A combination of a hydraulic classifier and a drag-classifier promised to fulfill the necessary conditions and to render possible a complete separation of slime from sand, and also to establish complete control of pulp-dilution throughout the entire mill. This should give closer control of all concentration operations and avoid the expense and nuisance of pulp-thickening devices and the losses occasioned by the escape of metal in pulp-thickening overflows.

Several years ago I began to work out the details of a machine that would accomplish this desired result. In the summer of 1915 I built a machine consisting of a combination of a cone-classifier and dewaterer. This was ready to start when a somewhat similar machine was described in the Mining and Scientific Press, which description was followed by a number of contributions showing that other engineers were working on the same problem.

In the summer of 1916 I built and installed in the Kittimac mill, near Silverton, Colorado, an improved machine of this type in which more perfect hydraulic classification was accomplished by so proportioning the sorting-column and arranging the sorting jets that the tendency for some mingling of the 'slime' with the sand by counter-currents was overcome. To make the machine still more positive, I have designed a revolving shutter, on the principle of the revolving doors used at the entrances to buildings, and placed this below the sorting-column so that all possibility of downward water-currents is shut off while the classification is made continuous.

The machine consists essentially of a hydraulic classifier, from beneath the hydraulic column of which the sand passes into a drag-classifier dewaterer. By varying the volume of hydraulic water used, the control of what will be thrown into the overflow product is very positive. The completely deslimed sand is delivered in a practically dewatered condition ready for division into parts best suited for the table to which it is to be sent, or ready to return to the ball-mill or tube-mill, if complete fine grinding is to be followed.

One of the most striking merits of the ball-mill as a substitute for grinding apparatus in which the pulp is discharged through screens is that the ball-mill does its best work with so small an amount of water that the removal of the finished product with all of the water used in the ball-mill plus the water necessary for desliming yields a pulp of minimum dilution.

The ore in this plant is crushed to 1½ inch size by rock-breakers at the mine and is delivered to the mill-bins by an aerial tramway. From the bins it is fed by a traveling-belt feeder to a ball-mill and ground to a practically finished product. The ball-mill discharge goes to a trommel, which returns a small amount of oversize. The undersize from the trommel goes to the drag-classifier, the fine product of which is taken off as a pulp so thick that the superintendent has found it advisable to dilute it with clear water before treating it in my improved flotation-machines, which are also part of the equipment of this mill. The ideal condition is satisfactorily attained, so that no pulp-thickening devices are needed in the preparation of the flotation-feed. The tables that are served with the sand coming from this deslimer divided into proper sizes by the rotary classifier, later to be described, have no slime in the back-water.

Where tables are to be used in treating the sand sizes, the sand-product of the fine-classifier is discharged with the addition of barely enough water to carry it through

a steeply inclined launder into the circular feed-pan of the rotary classifier.

The principle of classification made use of in this rotary classifier can be easily demonstrated. Take a portion of ore-pulp and wash it free from slime by repeated agitations and decantations. Into a burette, or a larger tube, closed at one end, introduce a few grams of washed sand and fill the tube with water. Put a depth of two or three inches of water in a pan. Close the pipe with a finger and invert it, submerging the open end in the water in the pan before removing the finger from the end of the tube. As the sand settles describe a circle

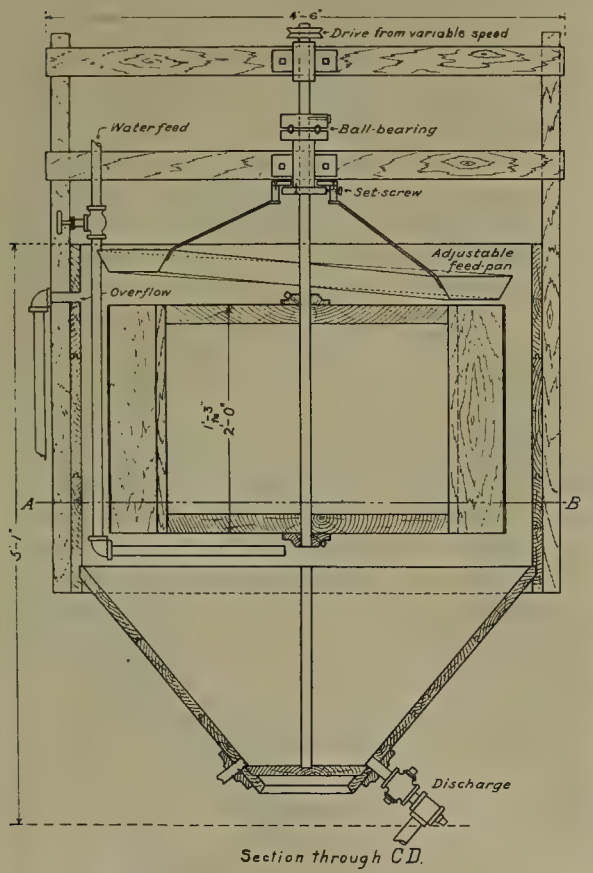


FIG. 2. ROTARY SAND-CLASSIFIER, SECTION.

slowly with the tube near the edge of the pan, so that all of the sand will be allowed to settle in making one revolution. The sand will be found to be graded from the coarsest to the finest. If this circle is divided into eighths, the sand in the segments will correspond to the sand obtained in the corresponding pockets of the rotary classifier.

I have found this laboratory method of sand classification useful in examining unsized pulp and portions of the sizes obtained in screen-analyses. If the operation is performed over a vanning-plaque submerged in a pan of water, the sand can be examined with a glass, if the plaque is carefully removed from the water, and much valuable information may be obtained as to the distribution of the constituent minerals in the various screen-sizes and the extent to which the minerals in the different sizes are broken free from each other.

The sand-classifier consists essentially of an upper rectangular tank in which is suspended a submerged series of vertical channels radially disposed around a revolving vertical shaft, the channels revolving above a series of pockets with independent discharge-spigots. The vertical shaft is revolved by a differential-speed mechanism by which its speed can be closely regulated. The free-settling ratio of mineral particles in water is utilized for classification. The classifier is filled with water to above the top of the vertical channels, of which there are 60 in the machine as now used. The pulp is introduced continuously from a slot in the rotary feed-

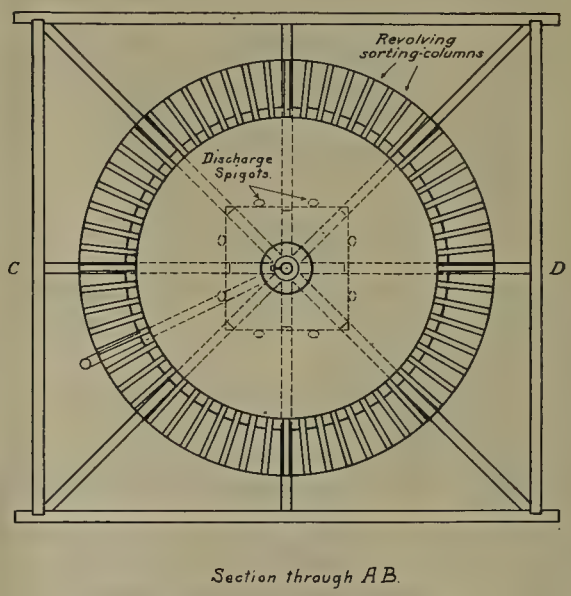


FIG. 3. ROTARY SAND-CLASSIFIER, PLAN.

pan at any desired point. At a speed of two revolutions per minute each of the revolving channels receives pulp for but one-half of one second, so all of the ore-particles have a practically even start in settling. The machine is so timed by an adjustable differential-speed mechanism that the last fine sand settles before the first coarse sand of a subsequent lot reaches the bottom of the channel. Thus there is a gradation of sand from coarsest to finest in the pockets and a different product may be drawn off from each of the spigots. The product of each spigot may be sent to a separate concentrating device or the discharge from any number of spigots may be combined to constitute the feed for a single machine.

In the Kittimac mill, near Silverton, Colorado, where these classifiers are being used in the treatment of a mixed sulphide ore, it is found desirable to give the discharge from the first coarse spigot to a single table, that

from the second spigot to a single table, that from the third and fourth spigots to another table, and that from the remaining spigots to a fourth table. In order to facilitate this mixing of the products, a shallow box containing eight pockets is hung below the rotary classifier, each pocket having connection with the adjoining ones through holes in the partitions separating them, these holes having plugs that may be removed as desired. Each compartment has an independent pipe-discharge from which it may be drained to the table selected to receive its product. The combining of products of different spigots with the use of nothing more than short lengths of hose is thus made simple.

The rotary classifier receives a perfectly deslimed and practically dewatered feed from which substantially all of the sand of a given fineness and all of the colloid material has been removed. The water necessary to supply the spigots so as to carry the sand through the launders to the tables, and to insure a constant water-level by giving a steady overflow, is supplied through one pipe.

The sand classification performed by this machine is apparently as satisfactory as can be desired and the tables treating its sand-products give a close cut between the different minerals and run so uniformly that the cutters frequently do not have to be re-set for hours at a time.

I am informed that a crude attempt was at one time made to make use of this principle of classification, but that it met with failure, as the essential conditions necessary to success were not complied with. Among the conditions essential to the attainment of success are the following:

The sand must be completely deslimed before introduction into the free-settling classifier; the number of sorting channels must be so great that in the period of revolution found necessary, each channel must be under the feed-spout for so short a period that practically all of the sand received by it shall have an even start in settling; the depth of the channels must be sufficiently great to permit of the distribution of the sand received at one time over a circle of such radius as to cover probably not less than eight discharge-pockets; means must be provided for regulating the speed of rotation so that the finest sand will all fall out of the channel before the coarsest sand of a subsequent charge shall reach its bottom; clear water must be provided in sufficient quantity to supply each of the spigots with enough water to carry its discharge to the desired point, and to afford a slight excess for an overflow to maintain a constant water-level in the classifier; and valves should be provided so that the amount of water discharging with each spigot product may be closely regulated. The use of a rotary circular feed-pan with one discharge-point permits of an independent regulation of the point at which the rotating sorting-columns shall receive the sand.

I believe that the classification made possible by the use of these two devices furnishes such a positive control of milling operations as has never before been obtainable.

Alaskan Semi-Centennial

Commenting on the semi-centennial of Alaska under the American flag, Secretary Lane estimates that the land for which we paid $7,200,000 in 1867 has brought more than $750,000,000 into the channels of American trade. This item shines out like a candle in the gloom of national thriftlessness, to which our attention is so regularly directed. After the $500,000,000 which we throw away annually by our prejudice in favor of cow's butter as against peanut butter; after the $250,000,000 which we lose anually in productive human lives by refusing to keep trespassers off the railroad rights of way; after the $365,000,000 which we could have, but do not, by introducing business methods into the Federal Government; after the half-billion dollars annually thrown away in the form of food values in skimmed milk; after the vast sums the farmers squander in their prejudice against decent roads; after ever so many other uneconomic factors which make it a puzzle how this nation has managed to keep out of the poor-house, it is a comfort to think of at least one investment that shows forethought and thrift. Perhaps it is the enormous profit we have realized on Alaska that has served to keep this country going.—N. Y. *Evening Post.*

Reactions of Sulphate-Solutions on Oil

It was suggested long ago in the Russian oil-fields that hydrocarbons are able to reduce sulphates to sulphides, and that they themselves are simultaneously oxidized to carbon di-oxide or to carbonates. Some of the sulphide formed in the reaction between the hydrocarbons and the sulphate-waters is undoubtedly oxidized to sulphur. Some of this sulphur is taken up again by the oil, which makes the oil heavier and more asphaltic. In the oil-fields of the San Joaquin valley the oil that has been most exposed to the action of the water generally contains the most sulphur, and is of the highest gravity. It seems probable that natural gas is also affected by these reactions, and that some of the carbon di-oxide formed is not taken up by the waters but mixes with the gas and lowers its heating value. The gas nearest the outcrop of the oil sands, where sulphate waters can most readily enter the strata, and where the reaction would naturally be most vigorous, may contain as much as 35% of carbon di-oxide. A preliminary report on Californian oil-field waters, containing a number of analyses and a discussion of the principles that control the chemical variations in the waters, has been issued by the U. S. Geological Survey as Bulletin 653, prepared by G. Sherburne Rogers, entitled 'Chemical relations of the oil-field waters in San Joaquin valley, California.'

COPPER production from the mines of the Chile Copper Co. amounted to 8,714,000 lb. in March, making a total for the first quarter of this year of 20,770,000 pounds.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

TREADWELL, ALASKA

DISASTROUS CAVING OF THE ALASKA TREADWELL WORKINGS.—GASTINEAU CHANNEL FLOODS THE GREAT MINES.

On Saturday at midnight, April 21, the ground lying between the main openings of the Alaska Treadwell mines and Gastineau channel settled along the plane of a fault that extends out underneath the channel, and the salt water of the strait quickly poured into the extensive underground workings of the Alaska Treadwell, Alaska United, and Alaska Mexican mines. The disaster did not come without warning, for there has been observed for many months a noticeable subsidence of the surface above the mine workings, and various plans had been considered to remove as much of the ore as possible so long as it continued to be safe to do so, but it was recognized that an eventual collapse was inevitable, though it came somewhat sooner than had been anticipated. The subsidence was being watched carefully and as evidences were unmistakable that a cave was imminent the men were hoisted to the surface and no lives were lost, but a number of horses and mules employed in tramming on the lower levels had to be sacrificed, as there was not sufficient time to save them. The engineers of the company believe that work can be continued and levels opened far below the bottom of the flooded workings, by using the shaft of the Ready Bullion mine. This shaft had been connected with the main workings that are now flooded, but realizing the danger of just such a catastrophe as has occurred, a heavy bulkhead was built in the long drift of the 1350-ft. level that formed the connection between the Ready Bullion and the Alaska Mexican workings. At last reports the bulkhead had exhibited no sign of weakness, and it is hoped it will hold.

Messrs. R. G. Wayland, general superintendent of the Alaska Treadwell group, P. R. Bradley, consulting engineer, and J. H. Mackenzie, who is visiting at Juneau, are in consultation at Treadwell.

LEADVILLE, COLORADO

IMPORTANT DEVELOPMENT IN THE DOWN TOWN AREA.—POVERTY FLAT TO BE EXPLORED AT GREATER DEPTH.—ACTIVITY ABOUT FRYER HILL.

The organization of the Dold Mining Co., in Denver, and its subsequent lease of the Northern property, adjoining the Coronado in the Down Town section are recent events in the Leadville district that promise big things for the future. The Dold Mining Co. is an organization of prominent Denver business men headed by C. J. Dold, a pioneer mining man of Leadville, who in 1879 was actively interested in the Tuscon mine, on Iron hill. He is familiar with the entire territory, particularly the Down Town area, and predicts that it will develop into an important and heavy productive centre. The company is well financed and will make a thorough exploration of the Northern property, which comprises eight acres, adjoining the Coronado on the north and directly in the trend of the big Down Town ore-shoots that have been developed through the Penrose, Midas, Sixth Street, and Coronado shafts.

The Northern, and a large surrounding area, including the Capitol, Clipper, Congress, and Castle properties, have been in litigation for a number of years owing to the conflicting claims made by the Carleton brothers, and former Governor Jesse F. McDonald, owner of a big tract in the Down Town district and manager of the Down Town Mines Co. which is now operating through the Penrose. Recently a decision was reached whereby the territory involved becomes the property of the Leadville Basin Mines Co., a Colorado corporation, in which both of the claimants become stockholders, with the Carleton interests in control.

The officers of the Leadville Basin Mines Co. are: J. K. Carleton, president; S. W. Eckman, treasuer; and S. M. Carleton, secretary. These three, with I. B. Humphreys, form the board of directors.

From the Leadville Basin Mines Co., the Dold Mining Co. has secured a ten-year lease on the Northern; and is placing the property in shape for operation. The shaft is 638 ft. deep and will be re-timbered. A large building has been moved onto the property, to be used as a hoist-room. The Colorado Power Co. is erecting lines to the property and installing transformers. A 52-hp. hoist is to be installed as soon as the buildings are ready.

The Northern and the surrounding territory, which the Dold Mining Co. is preparing to develop, is reported to contain three ore-horizons at as many contacts. The first contact was partly explored by past development, in the Northern and Coronado shafts lying between the white-porphyry and the Leadville blue lime. This contact underlies the greater part of the Leadville district. A second contact, of vastly more extensive mineralization, was found below a thin sheet of gray-porphyry in the blue lime. This contact was the source of an immense tonnage of ore extracted from the Coronado and Northern. The third contact, so-called, is the 'second contact' that is usually found in other parts of the district under the parting-quartzite in the white lime. This contact was reached and developed through the Coronado, but the Northern workings were never deep enough to reach it.

The possibility of the extensions of the third-contact ore-shoots of the Coronado continuing north into the Northern ground is the cause of the re-opening of the latter property at this time. It is stated that the Down Town Mines Co., developing the Coronado through the Penrose, has extracted ore from large deposits found right up to the Northern line.

The Coronado is 870 ft. deep, indicating that the Northern will have to be sunk 232 ft. to reach the contact. It is also stated that the presence of the Cloud City fault, traversing this territory between the Coronado and Northern, will make it necessary to sink the shaft of the latter still deeper to reach the ore.

That the developments at the Northern will meet with success is generally conceded. The property is in the centre of a rich area that has been productive of high-grade lead and zinc carbonate and silver chloride. Former operations at the Northern resulted in the extraction of ore worth hundreds of thousands of dollars, and it is believed that the third-contact orebodies will prove richer than those found above.

The Leadville Basin Mines Co. is also planning to undertake extensive development in its other holdings running north from the Northern into Poverty Flat. This territory is now one of the most promising sections in the district, and it will be thoroughly developed during the next year or two. The usual Leadville formations are all in place under the Flats, as is evidenced by the presence of the white-porphyry and blue lime in all of the shafts that have ever been put down in that area. The formations are much deeper here, however,

than in other parts of the district, owing to the succession of faults that have gradually raised them from the Down Town and Poverty Flat territories, east through Fryer, Carbonate, and Yankee hills. Deep mining will be necessary to uncover the orebodies in the Flats, and it is this development that the Leadville Basin Mines Co. will undertake.

Lead carbonate carrying hundreds of ounces of silver to the ton has been extracted from the old Seeley shaft by former operators, and similar ore is reported to have been found in the Delante property. The ore deposits, however, were not large nor continuous, but it is hoped that with greater depth they would be found to develop into extensive shoots.

It is stated by the owners of the Flat properties that an Eastern syndicate is being organized for the purpose of advancing operations throughout that section during the coming summer. Other enterprises are expected to follow, and it appears that considerable development will be undertaken in the territory. At present there are four properties active in the Poverty Flat area. The Jason, Alright, and Murcray, located near the slope of Fryer hill, are producing a steady tonnage of iron and manganese ores. The Davis shaft is being sunk to greater depth following small streaks of lead carbonate that were encountered on the 100-ft. level.

The Leadville Unit, on Fryer hill, contiues the sinking of the Jamie Lee shaft which is now nearing a depth of 700 ft. The parting-quartzite was cut just above the 600-ft. mark, and since then the shaft has been in white-porphyry and lime. Sinking will continue to the contact between the white lime and the gray-porphyry where large orebodies are believed to exist. Several new discoveries have been made in the upper workings of the Jamie Lee, Tip Top, and Harvard, where development is being carried into new territory. A steady tonnage of ore is being extracted.

Lessees on the Hayden property, on Fryer hill, have just completed sinking the shaft an additional 100 ft. The shaft is now through the parting-quartzite and into the white lime. Driving in this latter formation is underway. This property is producing a steady tonnage of zinc carbonate.

Development in the lower formations underlying the parting-quartzite, in the Fryer hill section, is being followed with great interest by local mining men. This area is one of the most important sections of the district and the discovery of rich orebodies in the second contact will be followed by the sinking of many now idle shafts into the new ore-zone.

The Fortune mine, in south Evans gulch, is being prepared for the largest development campaign that has ever been undertaken in that famous old property. Under the direction of Manager John McNeece, the shaft is being re-timbered and a second compartment is being opened for hoisting. Driving into new territory on several of the old levels will follow. Travison & Co., leasing the lower workings of the Fortune below the level of the Yak tunnel, are rapidly removing the cave that recently blocked their winze. The old Fortune vein was being opened through workings from the winze and a large and rich ore-shoot had been uncovered at the time of the cave. Pumps have been installed in the Resurrection winze, which is 50 ft. deeper than the Travison workings, and the entire vein is being drained. It is stated that developments in ore will be resumed during the month and that steady shipments will be commenced early in May.

TERLINGUA, TEXAS

LARGE PRODUCTION AND EXTENSION OF OPERATION IN TERLINGUA DISTRICT.—MINES AND WORKS GUARDED BY TROOPS.

There has been a steady increase in the quicksilver output of the Terlingua district during the last several months. Besides the existing cinnabar mines that are being successfully operated, several claims are to be developed by new companies that have been organized for the purpose. At present the different furnaces in the district are treating about 80 tons of cinnabar ore daily. The output of quicksilver for the past 12 months is close to 10,000 flasks. The Mariposa Mining Co. has two 10-ton furnaces in operation, and other furnaces, owned by the Chicos Mining Co. and the Big Bend Mining Co., are producing large quantities of the metal. These three companies are the principal ones now operating in the district. James Normand of Marfa, Texas, is president of the Mariposa Mining Co.; Howard E. Perry, of Chicago, is president of the Chicos Mining Co.; and W. D. Burcham is general manager for the Big Bend Mining Co. The proved cinnabar district has a width east and west of about 16 miles. It is not known how long it is for the reason that well-defined veins have been traced across the Rio Grande into Mexico and for some distance south from the border.

The great advance that has been made in the price of quicksilver since the War began has made it a very profitable industry. But for the fact that Terlingua is situated 90 miles from the nearest railroad point, it is believed that the development of large deposits of cinnabar ore here would be much more extensive than they are now. In order to protect the different properties from possible damage or destruction by raiding bands from Mexico, military guards are maintained at all of the mines and furnaces. The Rio Grande also is patrolled constantly by United States troops.

HOUGHTON, MICHIGAN

A LONG LIFE STILL IN SIGHT FOR CALUMET & HECLA.—POTATO FARMS NOW POPULAR WITH THE MINERS.—THE CONTACT PROPERTY AS A POTATO RANCH.

Fifteen years ago, the late Horace J. Stevens, one of the best informed publicists on copper mining in the United States, went on record as limiting the life of the Calumet & Hecla to ten years as an active producer, and allowed five years more 'to clean up.' At the present time the Calumet & Hecla mine has openings which practically insure good ground at a reasonable rate of production for ten years ahead, and the company has more money per share in its treasury than ever before in its history; has just completed the most profitable year in its 52 years of existence; has financial interests well placed in subsidiaries that are certain to be profitable producers for 20 years, in three or four prominent cases, and generally has an outlook for the future that is better than at any time in its career.

There is a great deal of Calumet & Hecla stock held here in the copper country of Michigan, as there has been from the very first. Every copper-country boy, and native-son, remembers from his earliest childhood that his father's one ambition has always been to accumulate enough Calumet & Hecla stock to be comfortable in his old age. As a security native-sons consider it in the same class with government bonds. As for the end in sight, so certainly predicted by men like the late Mr. Stevens, the Calumet & Hecla management may well be depended upon to maintain the organization, produce the copper, and provide employment for its thousands of high-class expert workmen for many years to come, just as that same management decided 15 years ago, that while the end of the Calumet conglomerate-lode might be foreseen at some time in the future, that offered no excuse for the disintegration of this, the largest and most important copper mining corporation in northern Michigan.

And the end of the Calumet-conglomerate, as an important producer of copper, is by no means in sight. In the recent purchase of the Tamarack property by the Calumet & Hecla, the latter company comes into possession of a great deal of conglomerate-territory that could not be mined by the Tamarack as its own, and yet, that assures a profit to the Calumet & Hecla when handled through that corporation. While the outlay for this property was $3,600,000, and to that must be added a considerable sum for the rehabilitation of No. 5 shaft, the

life of the Calumet-conglomerate is extended over a period of at least ten years at the northerly end.

In addition to the acquisition of this important section of Tamarack ground there is another important feature that ought to be considered in connection with the purchase of Tamarack. For instance, practically all of the Calumet & Hecla conglomerate shafts that have run to the boundary-line were in a grade of ore that could be operated at a profit, even at such great depth. It was not, of course, rich, like the conglomerate nearer the surface, but it was by no means too lean to work. Many of these shafts stopped because they had reached the Tamarack boundary-line. In the Hecla mine, No. 6 shaft is down 7874 ft., and 133 ft. under the 79th level. No. 7 is down 7977 ft., which is 140 ft. under the 80th level. At the South Hecla No. 8 is down 6102 ft. and sinking has been permanently discontinued at the 63rd level. The rich South Hecla shafts, No. 9 and 10, are down 8132 ft., 142 ft. under the 82nd level. At the Calumet, No. 2 shaft is 6186 ft. and sinking presumably will cease at the 63rd level, but this shaft, like some others, ceases because the Tamarack boundary-line is reached. Now that the Calumet & Hecla owns Tamarack, there is no boundary-line and while these depths once were considered formidable nothing but the poor quality of the rock will prevent a continuance.

Calumet shaft, No. 4, is down 7995 ft. and has to go to the boundary-line at the 81st level. The big double-shafts, No. 5 and 6, which connect with the Red Jacket perpendicular shaft, has attained a depth of 6155 ft., with the boundary at the 60th level, according to the last annual report, prepared before the Calumet & Hecla took over the Tamarack.

After many years of struggle, it may definitely be announced that the Contact, formerly Elm River, now is an assured commercial success. The old Elm River company operated as long as it was possible to collect assessments and pay its way. Then it retired, in 1910, and the Contact took its place—simply a change in name and the shareholders permitted to make an exchange, share for share, and continue to assume assessment responsibilities. No copper has been mined profitably since the first exploration work started. But now, the solution seems sure. There are 2300 acres of the best potato-soil in the Cloverland district on the Elm river. The agricultural experts agree on this. And the corporation as such has two chances, either to lease the potato-land, or raise potatoes instead of attempting to raise copper. This acreage, properly handled, ought to supply 500,000 bushels of potatoes at a net profit to the corporation of $1,000,000 this year. Potatoes are selling here, in the greatest potato-growing section of the United States, at $2.40 per bushel, delivered by farmers to the cars, wholesale.

Seriously speaking, on the potato question, it is interesting to note that the Calumet & Hecla company has offered to lease lands for potatoes, or other small farming-work, to its employees at practically no cost. As a matter of fact, every company-house, Calumet & Hecla, or otherwise, has a good-sized tract of land about it. And practically all of the miners have their little gardens. In order to assist in the garden-work, on a more elaborate scale, the Calumet & Hecla makes the flat offer to any of its workingmen to give them the use of fenced land for an insignificant rental, and is encouraging the organization of small potato-clubs among the working men. The average miner, with his eight hours on the job, has plenty of spare time for digging potatoes as well as copper, and the campaign to date has progressed to a point where the crop for 1917 is going to break all records unless climatic conditions are radically unusual.

The leaching-process, for a further saving of copper, is an assured success. Instead of handling 2000 tons daily, an additional plant will be built to handle 2000 more. The original plant handled only the sand from No. 2 re-grinding plant, but the new one will operate on sand from the mill. While there is a comparatively limited amount of copper extracted the cost has been but six cents per pound. The oil-flotation experiments indicate assured success in treating slime.

In reply to numerous inquiries it might be stated that there has been no material betterment in the underground conditions at the Superior since the first of the year. The company has paid one dividend, and another was recently announced. Contrary to the general impression, however, the Superior has not gone out of business, nor is the end in sight. At present there is at least 280,000 tons of profitable rock to be mined. Sinking to the 33rd level is the present plan. From that depth a lateral will be run to the ore-shoot which showed from the 18th to the 21st levels, 1200 ft. from the shaft. If values continue to this greater depth there will be at least double the present ore-reserve in sight.

SUTTER CREEK, CALIFORNIA

CENTRAL EUREKA TO ENLARGE OPERATIONS.—THE NORTH STAR DEVELOPMENT WELL UNDER WAY.—MINERS' WAGES INCREASED.

The Central Eureka Mining Co. will soon be running its 40-stamp mill to full capacity, as sufficient rock has accumulated and reserves of ore have been blocked out so that it will not be necessary to keep from two to four of the batteries hung up, as has been done of late. Station-cutting is in progress both at the 3350 and 3425-ft. levels and in the meantime considerable rock is being obtained from the short drifts on these levels. A donkey-engine and small skip is still used for handling this rock, but as soon as the stations are enlarged and adequate chutes provided, the large skips will begin hoisting ore from this new portion of the shaft. Repair work is in progress on the tailing-dam, where a portion of the restraining-wall gave way during the winter floods. Fred Jost is the superintendent, and W. J. Bryant, foreman of the Central Eureka.

Good progress is being made in running the various crosscuts from the North Star shaft of the South Keystone Consolidated Mines to prove the several claims of this group. Most of the work is being done on the 600-ft. level, where it has been found, after catching up slight caves, that a great deal more development work was done under former management than the present company anticipated, thereby shortening the time that will be required to reach the orebodies believed to exist in this promising ground. John A. McIntire of Sacramento, a director in this company, is at Sutter Creek this week.

The Plymouth Consolidated Mines Co. has addressed a circular letter to the mine-owners of the county, announcing an advance in the wages of employees, 25 cents per day, which it is understood will raise the average there to a level with what was paid at the Keystone, Original Amador, and Old Eureka prior to the strike. The mines last named were not seriously affected by the strike and the employees of the Plymouth Consolidated Mines returned to work upon the promise of this raise, after being out only a few days. A similar increase has been promised the Kennedy mine employees to take effcet this month.

Charles Peters, a pioneer of Jackson, is endeavoring to interest capital in the Good Hope quartz mine at Jackson. The property consists of three full-sized claims on which very little development work has been done with the exception of one 125-ft. shaft. The Good Hope claim lies several hundred feet west of the Zeila mine and only 200 yards from the main part of the town of Jackson.

Prof. Geo. D. Lauderback, of the Geological Department of the University of California, with a party of 21 students from the University, has been exploring the mineral resources of Amador county for more than a week past.

Chas. Hoerchner, of Mokelumne Hill, Calaveras county, has located an antimony deposit on Esperanza creek, five miles

from that town. The deposit is said to be extensive and valuable.

The May Pole quartz mine, half a mile from Mokelumne Hill, resumed operations last week, when H. Blackmore, of Stockton, put men to work on two shifts, driving the adit ahead to tap the lead under the old shaft, sunk in the early '60s. This mine has been idle for the past three months.

TORONTO, CANADA

THE GOVERNMENT FIXES AN ARBITRARY TAX ON THE NICKEL INDUSTRY.—INDICATIONS OF SERIOUS LABOR TROUBLES.—IMPORTANT DEVELOPMENTS AT PORCUPINE.

As a result of the long-continued agitation over the nickel question the Ontario legislature has passed an act for the taxation of mines which increased considerably the comparatively light tax formerly imposed on the nickel-mining industry. The Provincial tax, supposed to be levied on all mining companies, was 3% on the profits, but some years since the International Nickel Co., by a special arrangement with the Government, obtained a flat-rate of $40,000 per annum. Since then their output has been enormously increased. Another cause of dissatisfaction was that the company operating the Sudbury nickel mines, the Canadian Copper Co., a subsidiary of the International, consigned its output to the parent company at a nominal price, which did not represent anything like its real value, thereby lowering the basis for taxation. The new tax-bill, as finally adopted, discriminates between nickel and nickel-copper companies, and other mining companies, leaving the position of the latter practically as it was before. The tax on the nickel and nickel-copper concerns is fixed as follows: On profits in excess of $10,000 and up to $5,000,000, 5%; over $5,000,000 and up to $10,000,000, 6%; and so on, the rate increasing by 1% for every additional $5,000,000 of profits. Other mining companies must pay, as at present, 3% on profits over $10,000 and up to $1,000,000, and on profits above that amount an additional rate of 1% for every $5,000,000 additional profit. Important features of the bill are the provisions for estimating profits, which will no longer be figured upon the nominal values placed on the matte exported for treatment in the United States. It is enacted that the value of the refined metal, less the costs of treatment, marketing, and 15% allowance for depreciation, are to be taken as the profit, and that sales of nickel ore, or matte, by a subsidiary company to a principal that controls the value, are not to be considered *bona fide*. The tax, furthermore, is made retro-active as of January 1, 1915. It is officially estimated that the tax will compel the International company to contribute $1,000,000 per year to the Provincial treasury, instead of $40,000. Even this drastic measure does not satisfy the extremists, who opposed its enactment in a series of bitter debates, on the ground that it was not sufficiently far-reaching. The Liberal members, who have taken up the Government ownership of nickel mines as a popular election-cry, assailed the International as a pro-German monopoly, clamored for absolute Government control of the nickel industry, and wanted the bill made retro-active, back to the year 1912. They introduced a resolution calling for Government control of the refining of nickel, which though defeated by a straight party vote of 22 yeas to 47 nays, doubtless served its purpose of making a record for the next election campaign.

The Porcupine mine-owners are likely to have to contend with serious labor troubles before long, as a strong agitation among the miners of all the northern Ontario camps for an increase of 50c. per day all round is making headway. This was resolved upon at a recent convention of miners held at Cobalt, but the demand has not yet been formally presented. To head off the movement several of the Cobalt mine-owners have offered to give bonuses based on the selling price of silver —25c. per day when silver is over 60c. per oz., 50c. when over 70c., and 75c. when over 80c. But the men do not take kindly to the proposition as they regard the bonus as unstable and they want a permanent increase.

The mining companies of Porcupine are in a different position, for, as they say, the value of gold is stationary, and consequently they are not disposed to meet the demands for an increase. In case of a strike several of the mine-owners say they will close down. The output is already considerably curtailed by labor shortage. The Dome has pushed its workings on the 700-ft. level into the territory of the Dome Extension, on which it holds an option, and is developing deposits of high-grade ore. It is anticipated that the 1000-ton unit of the Hollinger Consolidated mill, now under construction, will be completed about the end of June. This will increase the milling capacity to about 2800 tons per day. The shareholders of the Dome Lake have authorized an increase in the capital from $2,000,000 to $3,000,000. Plans are under consideration for milling West Dome ore at the Dome Lake mill. The shaft on the North Thompson side of the Vipond-North Thompson has been timbered and a station cut at the 600-ft. level, where a drift is being run to connect with the old Vipond workings. At the Newray, a cross-cut on the 400-ft. level passed through a vein 5 ft. wide. The Slade-Forbes Asbestos Co. is shipping crude asbestos from its property to Cincinnati.

The McKinley-Darragh has ordered a second flotation-plant with a capacity of 200 tons, raising the total capacity to 400 tons daily. The Buffalo flotation-plant is now running at the rate of 400 tons daily. The Adanac has discovered ruby silver in a second vein in cross-cutting on the 400-ft. level. The Sukverado, of Gowganda, is installing a 100-hp. boiler and other equipment.

JOPLIN, MISSOURI

SPELTER FOR GOVERNMENT NEEDS AT COST.—PLANS FOR THE OCTOBER MEETING OF THE A. I. M. E.

The outstanding feature of the week's developments in the Joplin district was the discussion of the plan for supplying spelter for the needs of the Government on the basis of actual cost. The plan, so far as disclosed, contemplates the ore producers turning over 10% of their output at cost; the smelters then taking the ore and smelting it at cost, and turning the product over to the Government. On a basis of the present production in the Joplin district, this would result in a supply for the Government of from 1000 to 1200 tons of ore per week which should yield from 500 to 600 tons of metal. This would provide the Government with about 30,000 tons of spelter per year from the Joplin district alone, and if the remainder of the zinc-producing country make the same offer, it would give the Government all of the spelter needed for munition manufacturing at the actual cost of production. On the basis of present mining and smelting costs, spelter should be turned at from 5c. to 7c. per lb. f.o.b. smelters. This figure would compare very well with the ratio of prices already said to have been obtained by the Government for lead and copper which it will need in munition manufacture.

The Missouri section of the American Institute of Mining Engineers is now holding committee meetings and organizing for the entertainment and program to be given at the meeting of the Institute to be held in October of this year. The Missouri section, which will act in the capacity of host to the Institute, will hold a meeting at the Connor hotel, Tuesday evening, April 17, for the preliminary working out of the plans. Dr. H. A. Buehler, chairman of the executive committee, has called a meeting of the section, and it is expected that in addition to the executive committee, there will be a large number of the Institute members at the meeting in Joplin, April 17.

In addition to the Joplin-district membership, engineers from the oil-region, at Tulsa, Oklahoma, are greatly interested and are expected to join in the entertainment plans.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ARIZONA

Mohave County

(Special Correspondence.)—Oatman officials of the United Eastern Mining Co. announce that in March the mill treated 6585 tons of ore which averaged $23.84 per ton, making an extraction of 96.15% of the assay value. The bullion output was $156,962.59. The Big Jim Gold Mining Co. has called a meeting of the stockholders at Phoenix, Arizona, for April 24, for the purpose of ratifying the sale of the Big Jim mine to the United Eastern Mining Co. and for the exchange of Big Jim stock for stock of the Big Jim Consolidated, share for share. The Big Jim Consolidated, May 1, will commence the development of the Bluebird property which end-lines the United Eastern on the west. Big Jim stockholders will receive one share of United Eastern for six shares of Big Jim, which they may hold or sell as they will. President N. P. Moerdyke, of the Tom Reed Gold Mines Co., who spent the past week inspecting the company's mines, states that the Ben Harrison (old) workings of the mine contain 40,000 tons of ore of which 10,000 tons is broken in the stopes and 30,000 tons developed. This will supply the new 300-ton mill now nearing completion and no ore will be drawn from the Aztec workings until an aerial-tramway is constructed, excepting that taken out in development. Material for a 4000-ft. tramway will be ordered as soon as a representative of the manufacturing company arrives. It is expected that the mill will be completed in five weeks. The old mill produced in 1916 $528,946 from 39,182 tons of ore averaging $13.50. Production from the new mill will be at the rate of $4500 per day from 300 tons of $15 ore, according to calculations.——The cross-cut on the 500-ft. level of the Nellie is near the foot-wall of the vein, according to measurements. The shaft went through the vein at 390 ft. and cut 26 ft. of $9 ore.

Oatman, April 16.

On April 10 the sheriff received information that men were about to remove the mill from the Holy Moses claim in Gold Flat, near Hancock station, and upon going to that place found three men dismantling one of the engines. He placed all three under arrest and lodged them in jail.

Harvey Klotsch, manager for the Yucca Tungsten Mines Co., has contracted with J. W. Fettes to haul 200 tons of machinery from Yucca to the site of the mill close to the property. When the new mill is ready to run there will be a large tonnage of ore available. During the past year $100,000 worth of tungsten has been shipped to Pittsburg, the ore being dressed in a small mill with hand-jigs. A big compressor and machine-drills have been installed at the lower tunnel and the mine is now being opened several hundred feet below the old workings.

Pima County

The first ore of the New Cornelia Copper Co. was crushed and delivered to the first of the 12 tanks of the 5000-ton leaching-plant last week. This is the first large copper carbonate leaching-plant in this country and the second largest in the world.

It is expected that it will require from 15 to 20 days to bring the 25,000 tons of acid solution up to a strength in copper contents that is necessary for the electrolytic precipitation. It will then require another 12 or 14 days before the first cathodes will be ready for shipment.

The construction of this plant was begun a little over a year ago and was expected to be in operation not later than June 1 of this year. Systematic drilling has shown the existence of 40,000,000 tons of ore of which about one-third is carbonate and two-thirds sulphide, averaging in all, 1.51% copper. There is practically no overburden therefore no stripping. The running will be by steam-shovel. The copper is dissolved with sulphuric acid produced at the Calumet & Arizona smelter at Douglas. The plant will cost $4,000,000. The Calumet & Arizona Mining Co. owns approximately 76% of the stock of this company.

CALIFORNIA

The report for the week ended April 14 shows 20 new oil wells, making a total of 323 since the first of the year, 34 tests of water shut-off, 19 deepening or re-drilling jobs, and 12 abandonments.

Alpine County

(Special Correspondence.)—The old Leviathan mine, 8 miles east of Markleeville, is again in operation after a long idleness. The mine was successfully worked between 1863 and 1872, when high-grade ore was shipped to works at Dayton, where bluestone was manufactured for use in the silver mills at Virginia City. Large bodies of ore, some of which is high-grade, have been discovered and a company, known as the Leviathan Copper System, now proposes to develop the mine. The work will be done under the direction of John L. Henry. The office of the company is in Los Angeles.

Markleeville, April 19.

Butte County

Ten men are employed at the chrome deposits on the Curtis property, that was recently taken under option by F. Alexander.

Calaveras County

(Special Correspondence.)—A converter has just been installed at the smelter of the Penn Chemical Co. at Campo Seco, and the matte from the reverberatory furnace will henceforth be shipped as blister copper. The manager, A. P. Busey, Jr., has contracted with the Pacific Gas & Electric Co. for current, and electric power will be substituted for steam throughout the plant. A new electric hoist is being installed, and an underground electric hoisting station is being put in at the 1400-ft. level, capable of serving the operations of the mine to a depth of 2500 ft. below that point.

Campo Seco, April 18.

Nevada County

(Special Correspondence.)—A compressor and motor have been installed at the California mine, at Deadman Flat, four miles below town, and construction of a 10-stamp mill has been decided on. Sinking is proceeding in the shaft and good ore is said to be showing at several points. The property was lately acquired by King C. Gillette, of Los Angeles.

It is reported that a flotation-unit will be included in the new equipment to be added to the Central mill of the North Star Co., that has been making tests on its ores with flotation, and recently placed a small plant in commission at its Champion mine, near Nevada City, for the treatment of tailing. The old North Star mill will be dismantled. Splendid ore is being developed below the 6300-ft. level, and a large tonnage continues to be drawn from the North Star vein.

The 10-stamp addition to the mill of the Golden Center Co. is in operation and construction of the cyanide-plant is pro-

gressing. The main orebody has been opened to a depth of 1000 ft., and superintendent Charles K. Brockington is preparing to explore large areas of virgin ground. Frank Vestal, formerly with the Empire Mines Co., is in charge of the mill.

The new owners of the Union Hill mine, San Francisco men, have made the final payment on the property and have arranged for more vigorous work. The shaft has been deepened and lateral work started to intersect the Union Hill and other veins. Besides yielding much rich gold ore this property is noted for its production of high-grade scheelite.

Five hundred acres near Cherokee, that are covereed with tailing from old hydraulic properties, have been taken under option by the Guggenheims, according to the owners. The ground also contains much virgin gravel. Testing of the ground is proceeding and it is said an attempt will be made to recover the gold by means of dredges.

Specimen ore is again coming from the upper workings of the Red Ledge mine, near Washington. A good tonnage of milling ore is blocked out and it is planned to run the mill steadily. Clyde Cole and the Williamson brothers, of Washington, are the owners.

Grass Valley, April 15.

At the Allison Ranch mine, the water is being pumped from the shaft at the rate of 800 to 1000 gal. per minute, says the Grass Valley *Union*, with but one of the two electrically-driven pumps in operation. The shaft, an incline, is 1675 ft. deep, and there are stated to be 9000 ft. of drifts besides other workings. It is estimated by C. W. Brockington, the manager, that in two months the workings will have been unwatered to the bottom of the mine. The Allison Ranch mine was discovered in 1855, and was worked for over 11 years, during which time it is said to have produced $2,300,000 in gold. Small rich shoots occurred in the vein with low-grade ore between. The rich ore ran from $100 to $200 per ton, the average, including the low-grade ore, being about $50 per ton. It is stated that 46,000 tons was milled. In its early history the vein was stoped for 1000 ft. along its strike. It was always an expensive mine to operate, owing to the great influx of water, and the extreme hardness of the ore and the rock inclosing the vein—a hard tough greenstone. The mine was closed-down the latter part of 1866, but was re-opened early in 1869. After that it was frequently idle and again opened, until, after a long idleness, it was bought by John W. Mackay and considerable work was done on it, but it was again closed and remained idle for a long time. It was in operation, however, in 1900 for a short while, but the water could not be controlled, and the mine was once more shut-down and had remained idle ever since until recently. With the new electrically-driven pumps little trouble is anticipated by the present management. The new owners, the Grass Valley Consolidated Mines Co., certainly show abundant faith in the outcome of its attempt to operate this noted old mine, for, while the water has scarcely begun to be lowered in the deep shaft, it has already built a 20-stamp mill and provided every modern device necessary for the treatment of ore such as commonly occurs in the Grass Valley region.

San Bernardino County

(Special Correspondence.)—Samuel S. Arentz and W. A. Perkins, of Ogden, have made the final payment on the Ingomar mine near Calada, and recently purchased for cash, from C. L. Hyde and associates of San Diego, the Milford No. 2 claim, which adjoins the Ingomar on the west. Three claims now comprise the group. S. S. Arentz is operating the property and has 20 men employed. During March four cars of zinc carbonate and one car of galena (crude ore) were shipped, netting on board cars at Roach, Nevada, $8000, exclusive of mining costs. Ore is lowered from cliffs on a 1400-ft. two-bucket tram and hauled 16 miles to the railroad by a six-ton Knox tractor. The property is 20 miles south of Goodsprings, Nevada.

Roach, April 16.

At the Belmont mine, at Goldstone, Drum & Clancey are developing the vein.——James Gatkins is reported to have sold a part of his property adjoining the Goldstone Mining Co.'s mines for $6000, according to the *Barstow Printer*.——A property close to the Red-Bridg mine has shipped recently 300 lb. of ore said to be valued at $1500.——A telephone line connecting Barstow and Goldstone is to be built. The cost will be raised by popular subscription, enough having been already secured to purchase the poles and wire.——At the property of the Goldstone Mining Co. the mill is about ready and production soon will commence. Nels Anderson has succeeded Mr. Greenwalt as superintendent, the latter having gone to Nevada.

Siskiyou County

(Special Correspondence.)—The Hunter's Paradise copper mine, 10 miles below Happy Camp, on the Klamath river, is held under option by the Gray Eagle Mines Co. of Maine, and identified with interests of W. B. Thompson, of New York.

Fifteen men have been steadily employed in exploration and development since last September. Buildings, trails, and telephone-lines have been put into working-order. The group comprises several claims, three of which recently were patented. Old work amounting to 1100 ft. underground, done by the General Development Co., was dropped at the inception of the War.

The present prospective buyers have sunk a 6 by 8-ft. shaft 100 ft. in the vein, and at the bottom a 79-ft. cross-cut through 46 ft. of vein proves the width at this point to be 38 ft. This was about the width at the surface where the croppings assayed from wall to wall, 0.1% copper; 0.01 oz. gold; silver, a trace. The 46 ft. from wall to wall at the bottom of this shaft, 70 ft. vertically from the collar, assays 0.8% copper; 0.03 oz. gold; silver, 0.25 oz. From the east a cross-cut adit is being driven through the hanging wall to the vein at a depth of 205 ft. (vertical) under the bottom of the shaft; being 275 ft. (vertical) beneath the collar. This adit was in 458 ft. on April 1, and had entered the hanging-wall porphyry, thought to be 120 ft. thick. It is expected that copper ore of commercial grade will be cut on this level, if not where cut by the adit, then, by driving south along the vein.

A second hanging-wall cross-cut adit is being driven to the vein 1500 ft. southerly from the shaft. This is now in 510 ft., having entered the porphyry that everywhere overlies the vein, at a distance of 307 ft. from the portal.

Considerable time and money was dissipated in an adit 528 ft. long in the foot-wall, by which it was believed the vein could have been tapped. Extremely heavy ground necessitated the abandonment of this costly adit.

A segment of the upper part of this vein, approximately 900 ft. long and 500 ft. deep at the north end has apparently been faulted and thrust westerly 1000 ft. into Lane's gulch. The hanging wall of this part of the vein lying in Lane's gulch has disappeared, giving the impression, at first, that this 40-ft. vein is here more than 400 ft. wide. This dislocation of the upper segment of the vein is attributable to the twisting effects of a surface serpentine 'flow,' so common in the western Klamath mountains, as well as throughout the Coast Range. This serpentine approaches within 300 ft. of the vein at most points, except where it shoved off the upper segment of the vein and there of course it entirely over-thrust the vein. Subsequent faulting, and finally, the erosion of that part of this serpentine that caps the lower part of the vein, has exposed the vein in place with a gossan outcrop that is insignificant in comparison with the immense overturned segment in Lane's gulch.

It is clear that except for surface jointing-seams no disturbance or dislocation by the serpentine will be encountered beneath the land surface over which it originally spread. This is also true at the Gray Eagle property 16 miles distant.

Until the deeper adits, now being driven, reach the vein, no new appraisement of this important prospect can be made.

All work is being done by hand. The option has two years yet to run.

Happy Camp, April 18.

TRINITY COUNTY

The Trinity Gold Dredging Co. has let the contract for building a second dredge, the cost of which will be close to $350,000. The company already has one dredge in operation, the old Alta Bert. The new boat will have three times the capacity of the old one. It will have 82 buckets of 18 cu. ft. capacity. The present boat's buckets have a capacity of 9 cu. ft. The new boat will be capable of dredging 420,000 cu. yd. per month.

The hull, which will be of wood, will be 140 ft. long and 65 ft. beam. The timber for the hull will be sawed in the company's mill. The machinery will be made in Ohio. It has not been determined whether the heavy hauling of machinery will be made from Delta or from Redding. The company owns 3600 acres of ground and enough of it is gold-bearing to keep two dredges busy for 15 years or more.

COLORADO

BOULDER COUNTY

(Special Correspondence.)—The Boulder Tungsten Production Co. is grading for a new reduction-plant that will be situated in West Boulder. The company either owns or controls a number of important tungsten-producing mines and proposes not only to concentrate the ore but to make ferrotungsten. The object of the company is to make a product that can be sold direct to the consumers, thus eliminating the middlemen and brokers, and it is hoped thereby to give the industry in Colorado much greater stability.

At the Horsfall mine, at Gold Hill, which years ago was one of the largest and richest producers of high-grade gold ore, new buildings for a plant of modern machinery are being built. The shaft is being re-timbered and the entire property put in first-class condition.

C. E. Bradenburg, of Camp Brainard, has made a rich strike of gold ore that is creating a boom in that district.——Denver mining men have taken over the Snowbound mine and will supply capital for the development.——The big mill at Cardinal is to be remodeled and will include flotation. It will handle custom work, which is what is needed here.——The Huron mine, at Eldora, has been sold to Denver parties and work will immediately be started.——W. F. Harper will start the Mogul mine in a few days, with a large force.——The Revenge mine, at Last Lake, four miles west of Eldora, has produced the richest gold ore ever found in Boulder county. It is sufficiently developed to warrant the erection of a modern mill, which the owners say they will do this year.——Harry Barbee, who has an extension of the Revenge, is pushing development work as fast as it can be done.——The Kohlman crosscut adit is progressing rapidly and the objective point will soon be reached. A mill is contemplated on the Mairs wagon-road, on Middle Boulder creek, which is near the portal of the tunnel.——Postmaster W. C. Spratt has made a big strike on his property, the vein being over 8½ ft. wide, carrying high-grade gold ore.——John A. Wilson, of Woodlawn Heights, is doing extensive work on his properties.——Caribou, the oldest and richest silver camp in the early days of this State, is getting out its regular shipments from the Caribou mine. Extensive improvements are contemplated at the mill.

The oil craze has again hit this State and the people have gone wild over it. Wild-cat stock schemes are flooding the whole United States. Denver is the hot-bed of the schemers and stringent laws should be passed to protect the unwary. Such schemes do untold injury to the legitimate mining industry.

Eldora, April 20.

(Special Correspondence.)—Through a legislative investigating committee the State of Colorado is going to make a searching and thorough investigation of the so-called smelter-trust. The ore-producers want to know why they deliver a certain consignment of ore and do not get anywhere near the value in that consignment when the smelter settles.

Three years ago the mining men of Colorado organized the Colorado Metal Mining Association, backed by the leading miners in the State, and then began to demand an investigation of the smelters. This organization proved strong enough to go before the legislature, just adjourned, and, notwithstanding a great deal of opposition, secured the passage of a law for such an investigation with an appropriation sufficiently large to carry out the purposes of the law. The matter has been held up for some time by the Attorney General, who has finally decided that the law is constitutional and the committee will get down to work at once. The members of the committee are Senators Fincher and Candlish, and Representatives Ardourel, McDonald, and Nagel—all from mining counties.

The Colorado Metal Mining Association, a semi-official organization with offices in the Capitol building, will join with the legislative committee in making the investigation complete and thorough.

Denver, April 18.

CLEAR CREEK COUNTY

The Colorado Central Co., according to the Georgetown *Courier*, has increased its working force, and will make further additions to it, as the ground is opened to make a place for them.

The test-mill at the mine is doing good work and a flotation concentrate of combined lead and zinc is being separated, giving clean separations of high-grade in each metal.

The Marshall adit, which has been cleaned out to its extreme west end, has disclosed large bodies of low-grade ore, and also a fine vein of ruby silver and gray copper.

In the Equator adit the zinc orebody is 6 ft. wide, including a solid vein of 16 in., the rest being small veins close together. Concentration of this orebody at the test-mill has resulted in a concentrate that returns 14 oz. of silver per ton, with 45% zinc. The lead concentrate carries 450 oz. silver per ton and 81% lead. The fillings of the old stope on this level are full of zinc ore which is as high-grade as that in the orebody.

The driving of the Ocean Wave adit is going steadily ahead, and it is the intention of the company to drive this adit to the western end-line of the property.

IDAHO

CUSTER COUNTY

Fred H. Vahrenkamp, president and general manager of the Copper Basin Mining Co., operating near Mackay, reports the mine in splendid condition.

The company has blocked out an orebody 600 ft. long, 208 ft. wide, and 135 ft. deep. It measures 700,000 tons and carries 3½% copper, 2 oz. silver, and 80c. in gold, a total value of approximately $24 per ton.

The snow is too soft to permit hauling, but spring is approaching, and within the next 30 days shipping will begin at the rate of 100 tons per day.

Mr. Vahrenkamp is making arrangements for motor trucks and trailers for the haul to Mackay, which is 23 miles distant.

In the development of this great orebody the hanging wall has not as yet been encountered, but in several places from 12 to 14 ft. of ore that carries from 12 to 20% copper has been developed. Plans are being made for a mill of 500 tons daily capacity.

MICHIGAN

HOUGHTON COUNTY

(Special Correspondence.)—Production of rock from No. 7, Quincy shaft, is now 12,000 tons monthly. The production from No. 2 shaft, 18,000 tons. Laterals from the 44th to the 53rd levels, inclusive, at No. 2 are opening fine ground. In

No. 7, laterals from the 56th to the 71st are all in fine-looking ground. The copper output is sold up to August at good prices. There is no truth in report of a new mill, as the present arrangements for handling No. 7 rock at the Quincy mill are satisfactory and the Hancock Con. owns an interest with the Calumet & Hecla subsidiaries in the Point Mills plant. The best-looking Hancock rock is coming from No. 4 lode, west, where a lot of heavy copper, mass and barrel, is coming out. A cross-cut is running from No. 7 to the west lode. The characteristics of the formation are similar to those of the Quincy —barren ground for a time and then a widening of the lode and rich bunches of mass and barrel copper.

The mill-run on Cherokee rock, taken out in exploration work and hauled from the mine to the Copper Range siding on sleighs during the winter, is showing sensational copper. The bulk of the rock is producing No. 1 copper in the mill. The mill-run likely will net the company a substantial sum at this time.

Hancock, April 18.

NEVADA

Humboldt County

Seventeen bars of bullion was the sum of a shipment from the Rochester mill which passed through Lovelock, during the past week, says the *Review-Miner*.

Some high-grade specimens have been taken from the slag-piles of the old Oreana smelter this week, which show the wastefulness of the former methods of treating ores there. One piece was a slab of almost pure metal consisting of silver, lead, and antimony, which had formed in the crevices of the dump. This slab would weigh about 20 lb. and is but one of many which are being taken out during the process of shipping this slag.

Nye County

(Special Correspondence.)—By the payment of $54,000 on April 11 the Manhattan Consolidated Co. settled the litigation with the White Caps Co. that has been pending for five years. Some rich ore recently was encountered in the Consolidated, and, with all danger of litigation past, the management is preparing to increase the working force and begin making a substantial output.

The Wedge roaster for the plant of the White Caps Co. has arrived, being freighted from Tonopah by teams of from 16 to 24 animals. The crushing-equipment has been assembled and the management expects to have the mill in operation within a short time. It is officially stated that new development work on the 415-ft. level is proving satisfactory. Production of ore from the 315-ft. level will begin as soon as the mill is ready for service.

Vigorous work is proceeding at the Union Amalgamated, Morning Glory, Big Pine, Big Four, and several other properties. Preliminary steps have been taken for re-organization of the Original Manhattan Co. Under control of the Koontz interests, of Goldfield, the Mustang is to be energetically worked on company account. The important strikes in the White Caps and Consolidated mines have rejuvenated the district, but some mine-owners are showing a disposition to prefer the printing-press to the machine-drill as a means of securing publicity.

Manhattan, April 15.

(Special Correspondence.)—A shoot of shipping ore, 40 in. wide, has been opened in the raise from the 1050-ft. level of the North Star. It is apparently trending toward No. 1 raise and a cross-cut will be run from that point to find its extension. A shipment is ready for the West End mill. Ore of fair-grade is showing in the raise from the 1135-ft. level.

The Victor shaft of the Tonopah Extension has been practically freed of water after much trouble, and repairs are progressing. From the 1540-ft. level, east and west drifts and raises are advancing in low-grade quartz. Intermediate west drift, 539 ft. from the 1350-ft. level station, is advancing in excellent ore, the vein having widened from 5 to 6 ft. On the 1260-ft. level of No. 2 shaft, stoping is proceeding on the Murray, Merger, and O. K. veins, the Murray and Merger showing widths of 8 ft. of good ore. The mill is treating 2380 tons weekly.

The Belmont Co. is pressing work from the 800-ft. level to block out the new 761 vein, that is said to average 20 ft. wide with most of the ore of good milling grade. Stoping has begun and indications point to a large tonnage of good ore below the 700-ft. level. The Rhyolite, Rescue, Shaft, and Mizpah-Fault veins are yielding good ore in the deeper levels.

The Proskey Regent group of 17 claims at Rawhide has been acquired by the Mogul Mining Co., composed of Eastern capitalists. Equipment includes two hoisting-plants, compressors, and power-drills. One shaft is down 150 ft. A. S. Proskey is superintendent. The Mogul company also operates a gold property near Charlotte, North Carolina.

Tonopah, April 16.

Ore production of Tonopah mines for the week ended April 13 was as follows, according to the *Tonopah Miner*:

The Tonopah Belmont sent to the mill 3024 tons, the Tonopah Mining 2100 tons, the Tonopah Extension 2380 tons, the Jim Butler 700 tons, the West End 780 tons, the Rescue 251 tons, the Halifax 160 tons, and the Montana 66 tons, making the total production for the week 9461 tons, the estimated value being $175,028. This valuation is calculated on the gross milling value of the ore.

The Tonopah Mining Co. last week shipped 53 bars of mill-silver, valued at $87,500. During the same period the Tonopah Belmont Development Co. shipped 47 bars of bullion and 42 tons of concentrate from the mill at Tonopah, and 23 bars of bullion from the plant at Miller. The bullion from the Tonopah mill weighed 58,778 oz. and that from Miller 44,099 oz. The total shipment, including the concentrate, was valued at $133,689.30.

The West End Co. has discovered a new vein in the California mine, which was bought from the Ohio Tonopah several years ago. The recent discovery was made in a cross-cut far west of any of the old workings of the West End property. The vein occurs at the contact of the West End rhyolite on the foot-wall and trachyte on the hanging wall. As yet no information as to the value of the ore found in the newly discovered vein is given out by the West End management, but as the discovery is in undeveloped territory it has created much interest in that part of the district.

Storey County

It is reported officially that some very good ore is being developed between the 2700 and 2900-ft. levels of the Mexican mine, on the Comstock Lode, where ore running $60 per ton has been found in the Patton winze connecting the levels mentioned. The ore is directly beneath a bonanza orebody mined in the ground between the 2200 and 2500-ft. levels of the Mexican, and from which over $1,000,000 was taken.

NEW MEXICO

Socorro County

(Special Correspondence.)—At the Trilby mine the bottom level is being advanced to the east and results thus far are good. The property is owned by H. O. Bursum and the Kirkpatrick estate.——Owners of the Iron group, in south part of the district, have been developing continuously for several months, driving a cross-cut adit which will cut the vein at a depth of about 150 ft. It will take several weeks more to reach the point.——Development of 900-ft. level in the Last Chance mine is being pushed both east and west, with encouraging results. This property has been a continuous producer of gold and silver for over 13 years, during which time upward of $5,000,000 gross has been mined. Its successful operation was initially due to the energies of Ernest Craig, who subsequently returned to England.

The Oaks Co. is shipping ore to a custom-mill from both the Clifton and Maud S. properties. The latter was only recently taken over under lease and the results of work in the brief interval are meeting the anticipations of the management. The company has also arranged with the owner of the Deep Down whereby this property is added to its central group, comprising the Clifton, Eberle, Maud S., and Deep Down, occupying a position in the district that will have a controlling influence on future operations. The Deep Down shaft, near the centre of this group, now down about 250 ft., is being re-timbered, the head-frame overhauled, and preparations made for installing a hoist, compressor, and pumps, when it will be continued to 500 ft. and drifts extended into adjacent territory. The group as a whole has produced around $1,000,000 in the past from what are now considered little more than surface developments.

From operations covering last half of March the Socorro Mining & Milling Co. shipped 18 bars of gold-silver bullion, an increase of 4 bars over the production for the first half of the month.

The Mogollon Mines Co.'s output for the last half of March was 17 bars of gold-silver bullion, compared with 13 bars for the first 15 days of the month. The company recently paid a 5% dividend on outstanding stock.

At the Johnson mine, owned and operated by the Socorro Co., a compressor was recently installed and machine-drills are now employed in the development work, and in advancing the lower levels.

A new oil-burning furnace has superseded the old-time coal-forge in the blacksmith-shop at the Mogollon Mines Co.'s plant, effecting a marked reduction in steel-sharpening cost.

At a special meeting of the stockholders of The Oaks Co. in March its common stock was increased from $500,000 to $1,000,000 and its preferred stock changed from a 10% non-cumulative to a 7% cumulative stock and made preferred as to both dividends and assets. Including that of March 1, four consecutive monthly dividends of 1% each were paid on outstanding preferred, and on April 1 the disbursement was 1¾%, to meet conditions of the new issue of stock. The next dividend of 1¾% will be paid July 1 and quarterly thereafter.

Mogollon, April 18.

OREGON

Jackson County

(Special Correspondence.)—The history of quicksilver in Gold Hill district dates back to 1878, when Wm. Mayfield, Sr., an early settler in Rogue River valley, discovered cinnabar on the property known as the Mercur claim, now owned by Dr. W. P. Chisholm, of Gold Hill. The mine is 12 miles north of Gold Hill, and comprises 20 acres. It is contiguous to the Little Jean, and the 36 claims held by the Utah Quicksilver Co., of Salt Lake City. From the time of discovery, and until he sold the property to Chisholm in 1900, Mayfield annually distilled mercury from the ore by roasting it in a crude manner. He disposed of it to the placer miners in this district, who used it in their sluices to catch the flour-gold. After Chisholm purchased the Mercur claim he located the Little Jean, an extension on the Mercur vein. These two claims were inactive until two years ago when Chisholm employed H. A. Ray and G. L. Haff, the discoverers of scheelite in this district, to develop his properties. They exposed the vein at intervals by adits for 2000 ft.; the greatest depth attained was 75 ft. Since that time the Utah people, and others, have located the main vein for several miles on the north and east. The strike of this vein is N. 53° W., and at an elevation of 2500 ft. It occurs along a granite-sandstone contact, where the granite is in part pegmatitic. The mineralized zone is from 100 to 200 ft. wide. It is not a well-defined vein, but is mineralized along an irregular contact. The ore, or mass, contains cinnabar, native mercury, pyrite, gold, zinc, silver, and a heavy black mineral resembling meta-cinnabarite. Samples taken from all of the adits assayed from $5 to $6 per ton in gold, $5 in silver, 2½% zinc, and 1% mercury. The cinnabar appears all through the rock and also in the hanging and foot-walls in the form of seams and kidneys. The seams are from 6 to 20 in. thick, and average 17% mercury. This last year Chisholm has employed two miners in developing his property, and during this time they have retorted and shipped 800 lb. of mercury, using a bench of three 6-in. retorts 4 ft. long. During this time Samuel Bertleson, of the Utah company, has retorted and marketed from 600 to 800 lb. of quicksilver from the Rainier claim. The Mountain King quicksilver mine situated two miles south of the Chishold group seems to be on the same vein. The same formation is found at both properties. The vein on the Mountain King strikes nearly west. Except in the solid quartzite, much faulting is in evidence in all directions. The Mountain King is owned by J. R. Hayes, of Detroit, Michigan, who is represented here by Alfred Lewis, of Gold Hill. This property consists of 800 acres of patented land, and is covered with valuable fir timber. This property was worked the past season under a lease and option held by J. A. Robinson, of San Francisco, who did considerable development work on the property. This property and the Chisholm group are the only two mercury properties in this district which have been extensively developed.

Gold Hill, April 16.

TEXAS

Travis County

(Special Correspondence.)—R. C. Walker of Austin is developing a large deposit of celestite, situated three miles north of here. He recently made a shipment of a carload to Philadelphia, and this is to be followed by others that will go to fill an initial order for several hundred tons. This ore will be used in the manufacture of fusees, and for other purposes, and is in large demand at this time. Mr. Walker will install additional equipment for enlarging the work upon his property. The ore deposit is shown to be large by the explorations so far made.

Austin, April 18.

CANADA

Ontario

(Special Correspondence.)—The shaft of the Porcupine V. N. T. has reached a depth of 620 ft. A station has been cut at the 600-ft. level sufficiently large for the installation of a hoist that will permit of continuing the shaft to deeper levels. Cross-cutting toward the vein is under way and should cut the vein at a point 52 ft. from the bottom of the shaft. The formation exposed in the cross-cut shows greater schistosity than in the vicinity of the vein, on the upper levels, and indicates that the shear-zone is particularly strong at this depth. When reached, the vein will be driven on both ways to explore the ground underlying the workings on the Vipond side and that lying south of the main shaft on the North Thompson side.

Since the beginning of the year stoping has been confined to the 200 and 400-ft. levels. At the 200-ft. level the vein in the stope has increased in width from 5 to 6½ ft. and the value from $7.50 to $9 per ton. This stope is being lengthened and timbered. The stope on the 400-ft. level has been timbered for 280 ft., and has reached a point 52 ft. above the drift. The average width of the vein for the entire length as far as opened is 12 ft., with places up to 20 ft. The average value at this point is around $10 to the ton. A total of 545 ft. of stoping has been done on the various levels to date.

The breaking up of the ice in the Mattagami river has caused a shortage of power, which materially retarded operations at the mine from the middle of March until April 1. It is understood that power is now available.

The tonnage treated from January 1 to March 17 amounted to 6890 tons, an average of 94 tons per day. The gross produc-

tion during that period was $48,996.20, an average recovery of $7 per ton milled. Extraction has approximated 90% of the total gold content of the ore. Of the ore milled approximately 5000 tons was broken from the backs of the drifts preparatory to opening stopes. This ore contained considerable waste which it was impossible to segregate. Recently the tonnage going to the mill has averaged $10 to the ton and has been drawn entirely from the stopes. The difficulties in treating the carbonaceous schist that occurs in some of the ore has been overcome, and from now on a minimum of 100 tons daily will be treated.

The Ingersoll-Rand compressor (1083 cu. ft. capacity) has been received and the foundations for it, and the motor, are in the course of preparation. The motor for this unit will not be shipped until about April 20, and the compressor will temporarily be driven by the 150-hp. motor that is now running the Vipond compressor. This will permit of the employment of 9 machines underground as against 6 at present. The new transformer-house is practically ready for one of the transformer-sets now in use at the old Vipond plant. The completion of the above work will centralize operations considerably, and reduce overhead expenses.

Porcupine, April 10.

COSTA RICA

The mineral resources of the Pacific slope of Costa Rica are important, says the *Bulletin* of the Pan-American Union. Gold has been mined at intervals since before the Spanish conquest. The value of gold exported in 1915 was $800,294. A small amount of silver (value $6122) was also exported. Recently a large manganese field was discovered and numerous claims have been located. This orebody is remote from transportation facilities, and occurs in a blanket-formation. Many other minerals are known to exist, but development awaits the coming of additional railways.

Oil has recently been discovered in Costa Rica, apparently in paying quantities. A concession to explore the oil-bearing lands, which are located in San Jose, Guanacaste, and Alajuela, was recently given to an American syndicate. A company will be formed to fully exploit the possibilities of the field.

JAPAN

The Furukawa Co., at its Ashio smelter is installing a Cottrell electrical precipitation-plant. Also a similar plant is being put in the Asano Cement Company.

WESTERN AUSTRALIA

The South Kalgurli Consolidated (Ltd.) reports for February that 8619 tons was crushed, producing 1973 oz. gold having a value of £8345. Working costs were £9958, leaving a deficit of £1613.

The Ivanhoe Gold Corporation reports the return for January, as follows:

	Gold, oz.
19,510 tons of ore crushed, yielded	2,591
(100-stamp mill running 27 days 13 hours)	
9,084 tons of sand treated, yielded	1,088
8,793 tons of slime treated, yielded	2,542
1,633 tons of concentrate treated, yielded	1,374
Total yield	7,595
Value	£32,243
Average value of yield, per ton	33s.
Estimated profit for the month	£9,003

VILLAGE DEEP, LIMITED

The Village Deep, Ltd., for the year ended December 31, 1916, reports: Ore received from the mine, 179,184 tons. Waste sorted out, 13.7%; crushed, 156,700 tons. Number of stamps operated, 180; number of tube-mills operated, 7; mill yield per ton, 4.85 dwt.; assay value of pulp, 2.571 dwt.; total yield, 54,842 fine oz.; total yield per ton, 7 pennyweights.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

COREY C. BRAYTON is at Butte.

MORTON WEBBER is at Oroville.

T. W. MATHER has gone to Dutch Guiana.

G. C. BATEMAN has returned to Toronto from Arizona.

N. M. MUIR will be in Kansas and Oklahoma for the next two months.

HENRY BRINGS, formerly at El Paso, has come to San Francisco.

A. J. UNDERWOOD is now manager of the Lluvia de Oro mines, in Chihuahua, Mexico.

A. P. BUSEY, JR., manager for the Penn Chemical Co., was in San Francisco last week.

JOHN L. HENRY is manager for the Leviathan Copper System in Alpine county, California.

JAMES M. HYDE is at Butte, in connection with the new flotation suit, now in course of trial.

S. S. Fowler passed through San Francisco on his return from San Diego to Nelson, B. C.

DRUMMOND MACGAVIN is here from Toronto, intending to join the Engineer Corps of the Army.

WILLIAM C. MADGE will sail from Victoria, B. C., on May 10, on his way to the Ridder mine, in Siberia.

G. M. SWINDELL, secretary of the Chamber of Mines and Oil, has returned to Los Angeles from Sacramento.

ANDREW M. TWEEDY is resident manager of the Zaruma mines in Ecuador and L. O. KELLOGG is superintendent.

E. H. ROBIE, metallurgist at the Cliff mine, Sudbury, was in San Francisco on his way from Arizona to New York.

WALTER ARNSTEIN has been appointed manager of the Bully Hill group of copper mines, in Shasta county, California.

H. H. NICHOLSON has been appointed general superintendent for the Plinco Copper M. & M. Co., in Plumas county, California.

FRANCIS S. SCHIMEEKA, who has had charge of the leaching department of the Shannon Copper Co., at Clifton, Arizona, has resigned.

HENRY N. THOMSON has resigned as metallurgist with United Verde Copper Co. and is engaged in consulting practice at 918 South Kingsley drive, Los Angeles.

Obituary

BERTRAM C. BELL was killed April 15 by being caught in the machinery of the cyanide annex of the Argonaut mill, which is operated by Simonds & Latham. He was a graduate of the mining college of the University of California of the class of 1913, and had been employed at the plant but a month. He had previously been in the employ of Simonds & Latham in their cyanide plant at the Melones mine, in Calaveras county.

EARL C. BACON died on Monday, April 9, at his home in North Salem, New York, after a short illness. Mr. Baker was an engineer of recognized ability. He was a pioneer in the development of hoisting-engines in the United States, and it was he who first placed in operation in New York city the new familiar engine for hoisting materials in buildings under construction. Also he designed and superintended the building of the first asbestos mill in Canada, and was consulting engineer for a number of important mines.

THE METAL MARKET

METAL PRICES

San Francisco, April 24

Antimony, cents per pound	23
Electrolytic copper, cents per pound	37
Pig lead, cents per pound	9.25—10.25
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$113
Spelter, cents per pound	12
Tin, cents per pound	55
Zinc-dust, cents per pound	19—20

ORE PRICES

San Francisco, April 24

Antimony, 50% metal, per unit	$1.80
Chrome, 40% and over, f.o.b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tungsten, 60% WO_3, per unit	18.00—20.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 50% (under 35% metal not desired), cents, unit	37—44

Manganese ore, 40 to 45%, sells f.o.b. Chicago at 58c. per unit with a penalty of 50c. per unit for more than 8% silica.

EASTERN METAL MARKET

(By wire from New York)

April 24.—Copper is weak and quotations are nominal. Lead is firm at 9.40 to 9.50c. Zinc is weak and somewhat lower, at 9.50. Platinum remains unchanged at $105 to $111.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
Apr.	18	31.50	Mch. 13 — 36.25
"	19	31.30	" 20 — 35.87
"	20	31.50	" 27 — 35.62
"	21	31.50	Apr. 3 — 34.58
"	22 Sunday		" 10 — 33.83
"	23	31.50	" 17 — 32.75
"	24	31.50	" 24 — 31.47

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	....	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
Apr.	18	74.00	Mch. 13 — 75.06
"	19	74.62	" 20 — 72.91
"	20	74.87	" 27 — 72.06
"	21	74.87	Apr. 3 — 72.98
"	22 Sunday		" 10 — 73.72
"	23	72.87	" 17 — 73.27
"	24	73.25	" 24 — 74.08

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	....	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
Apr.	18	9.40	Mch. 13 — 9.50
"	19	9.40	" 20 — 9.75
"	20	9.40	" 27 — 9.50
"	21	9.40	Apr. 3 — 9.40
"	22 Sunday		" 10 — 9.35
"	23	9.50	" 17 — 9.35
"	24	9.50	" 24 — 9.43

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	....	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound

Date		Average week ending	
Apr.	18	9.75	Mch. 13 — 10.87
"	19	9.75	" 20 — 10.69
"	20	9.50	" 27 — 10.74
"	21	9.50	Apr. 3 — 10.71
"	22 Sunday		" 10 — 10.64
"	23	9.50	" 17 — 9.87
"	24	9.50	" 24 — 9.58

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	....	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date			
Mch.	27	120.00	Apr. 10 — 115.00
Apr.	3	115.00	" 17 — 115.00
			" 24 — 113.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	....	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

Considerable business has been done during the past week, during which the quotation fluctuated from $115 to $120, the latter figure being maintained today, though quantities are obtainable at a concession from this latter price. Of course, the price quoted is for Californian virgin, and other grades are only accepted at a concession from these prices.

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	48.25	51.49	....	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

TUNGSTEN

The meeting of the tungsten producers of the United States has brought to light the fact that the present demand for tungsten ore is considerable. That in order to meet this demand by home production, it is necessary to advance the price, thus bringing into the market again ores which would not pay to be mined at the lower figure. Shipping conditions make a reliance upon foreign importation absolutely impossible and the scarcity of freight room has already reduced the imports to a large extent. January statistics showed imports over 600 tons from all sources. February showed only about 350 tons, and it is doubtful whether the March arrivals will exceed 200 tons. The imports from South America, especially Argentine, have stopped or have been heavily reduced, partly on account of the shortage of shipping space, and partly on account of contracts made by the allied governments from South America to Europe. This, and the heavy sales made during the first three months of this year, fully justify an advance, and the Atolia Mining Company of California, no doubt the biggest producer in this country, has adopted a schedule to come into force on May 1, fixing the price for 60% scheelite at $20 per unit with 30c. variation up and down. No doubt the other producers of the United States will follow this policy. Of course, it must be clearly understood that this schedule applies to good-class ore, especially foreign ores, that generally contain tin and copper, which are most objectionable impurities, that is now sold at a discount from the high grade. $18 has been paid for foreign ores available for immediate delivery and of fairly good quality, but our market is practically bare of supplies. Sellers of ore are now holding for prices from $18 to $20, and at these our market is quite strong. The business transacted during the past week has again exceeded several hundred tons in the New York market alone.

ANTIMONY

The spot demand is not quite as pressing, arrivals having taken care of the most urgent requirements and the nominal quotation is 34c., without finding buyers for quantities thereat. Forward antimony is in good demand; 23c. has been paid for February shipment with April shipment offered around 15 to 16c. Needle antimony has realized 13c. for spot and 8 to 9c. for future delivery, according to position. Antimony ore remains as scarce as ever and there has been little business of late.

MANGANESE

The demand continues very strong; 85c. has been paid on the basis of 45%, which would make the 50% manganese about 90%. Chemical ore is quoted from 4½ to 6c. per pound, according to grade.

PLATINUM

The price of platinum remains unchanged at $105 for the soft unalloyed metal, and $111 for the hard natural platinum-iridium alloy.

Eastern Metal Market

New York, April 18.

The dominating factor in the non-ferrous metal market is uncertainty as to just how much copper, lead, and zinc the Government, and also its Allies, are to need. Until this is settled, more or less inactivity and dullness will probably prevail.

Copper has developed further weakness and is lower on small buying.

Zinc continues to weaken on offerings by sellers but little business is reported.

Lead is firm with a stiffening tendency.

Tin is strong and a little higher but not active.

Antimony is more plentiful and easier.

In the steel market prices continue to advance, though domestic buying is some lines is less than in March. Buyers in general are more or less perplexed. Wire has been advanced $6 per ton by a leading independent company, and scrap has gone up in Chicago. Buying of steel rails for the last quarter of 1918 is conspicuous. France has purchased two lots of 20,000 tons each for that delivery, and the Northern Pacific has contracted for 40,000 tons for the same period. The market is strong and most forms of steel are as hard to get as ever.

COPPER

The sale of copper to the Government a few weeks ago at 16.67c. per lb., and the probable further requirements of both our Government and of the Allies, have worked to unsettle the entire market and partly to disorganize it. In the absence of a large demand, and consequently few sales, the sellers in general have been disposed to let the market go. The result has been lower prices, especially the past two or three days. Yesterday spot electrolytic and Lake were both quoted at about 31c. for nearby and April delivery, New York, though this is a nominal quotation. Some, however, would place the quotation higher, one dealer quoting 33c. for spot metal. A fair amount, however, of spot electrolytic was sold yesterday at 31c., New York. On April 17 future metal was quoted as low as 28c., New York. The market in general is lifeless and weak. The explanation is that buyers are waiting until something definite is known regarding the quantities that will be required by both this Government and the Allies. It is generally believed that the latter will secure the copper at the same price as the United States, but the quantity they will need is either large or small, depending on the viewpoint, with nothing definite known. The London quotation for spot electrolytic yesterday was £147, a decline of £4 from last week.

TIN

The proposition of a Government tax of 10c. per lb. on pig-tin came as a distinct surprise on Monday and has been widely discussed in the trade. The concensus of opinion is that while such a tax is possible, it is hardly probable and that it will be rejected by Congress. Such a move is regarded as against the interests of both the trade and the Government, and as likely to bring about an effect opposite to that generally desired economically. While the price of tin cans would hardly be touched, the burden would fall on the tin-plate maker and the tin dealer. The action of the market this week has thus far borne out the trade's diagnosis. There has been no boom, as might be expected, following such an announcement. On Monday a moderate business was done but not as much as was expected—probably 150 tons in all positions—and on Tuesday the market was decidedly quiet, with the bulk of the business done in futures. Nearly all of last week the market was dull with little business done, except on Friday, when about 120 tons was sold, mostly futures, with nearby metal quiet. The quotation yesterday was 55.25c., New York, for spot Straits. The arrivals up to April 16, inclusive, were 1795 tons, with 2812 tons reported afloat. Tin imports at Pacific Coast points in February were 1,011,705 lb. through San Francisco, and 1,299,954 lb. through Washington, with 30,098,335 lb. remaining in warehouse February 28, 1917. The London quotation yesterday for spot Straits was £217 17s.6d.

LEAD

The market stiffened early this week, after a week of comparative dullness and inactivity. Yesterday the quotation for prompt metal was 9.20c., St. Louis, or 9.40c., New York, a slight advance over the previous days. This firmer tendency is due to the fact that sellers are holding what lead they have until something definite is known regarding the needs of the Government for both the army and navy. Information regarding this is closely held, and the firmer tendency is expected to continue until definite reports are officially known. Some small sales of future metal were made last week at 9c., New York, and of prompt shipment from the West at 9.25c., New York. The London quotation for spot lead yesterday was £30 10s.

ZINC

There is no abatement in the tendency of the market to weaken despite the fact that very little business is being done. Consumers are averse to committing themselves under present conditions and it is believed that very little buying has been done beyond July 1. The declining market is due to offerings by some interests termed 'weak sisters,' any small sale or quotation making the market. Because of the continued weakneess in the market the price of zinc ore has receded $5 per ton, until the quotation is $65 to $80 instead of $70 to $85, depending on the quality. The quotation yesterday was 9.50c., St. Louis, or 9.75c., New York, for prompt and April prime Western spelter with a possibility that 9.37½c. could be done.

ORES

TUNGSTEN. The action of the producers at their meeting in San Francisco last week in setting an official price, as understood here, of $20 per unit for concentrate is not favorably regarded. The price is at least $2 above any sale made in many weeks or months. The fact that a prominent owner of a leading tungsten mining company is also influential in Government War-defence matters is looked upon with some suspicion. Why should tungsten dealers raise their price when copper and steel producers are reducing theirs? Several hundred tons are reported sold in the last week. The quotation here is about $17 to $18 per unit, depending on the quality. Ferro-tungsten is obtainable at about $2 per lb. of contained tungstic acid.

ANTIMONY. The ore is reported very scarce and little business has been done.

MOLYBDENUM. The quotation for wulfenite is from $2 to $2.25 per lb., but very little is offered. As to molybdenite, the position is as unsatisfactory as ever. Thirty tons of ferro-molybdenum were cancelled recently on account of the suppliers being unable to get the raw material in time to fill these orders. Whatever ore is coming on the market is paid for at fancy prices and it is hardly possible to speak of a regular market at all. The quotation is $2.50 to $2.75 per unit for high-class ore.

MANGANESE. There is a considerable demand for furnace-ore and 80 to 85c. is paid, delivered at smelter on the basis of 50% metallic manganese. Chemical ore (manganese di-oxide) is quoted from 4½ to 6c. per lb. according to grade.

Company Reports

BROKEN HILL SOUTH SILVER MINING CO.

The report for the half year ended December 31, 1916, shows a total production of £452,469, against which the working costs were: ore extraction £135,815; ore treatment £40,172; and mine development £20,691. The balance carried to profit and loss account was therefore £255,789. Additions to plant during the half year cost £17,032. Two dividends were paid amounting to £120,000. The ore hoisted was 157,059 tons, assaying 6.7 oz. silver, 14% lead, and 13.8% zinc. Of the ore sent to the treatment works, 96.1% was broken by contract, 1% was mined on wage, and 2.9% came from mine-development. Development consisted of 1373 ft. of driving, 491 ft. of raises, 179 ft. of shaft, and 3263 ft. of diamond-drill holes. The average number of men employed on the surface was 454 and underground 922. The ore-reserves at the end of 1916, making no allowance for probable ore, amounted to 3,500,000 tons. The products from the concentration plant were as follows:

Product	Net weight, tons	Assay value: Lead, %	Zinc, %	Silver, oz.	Proportion of metal content: Lead, %	Zinc, %	Silver, %
Concentrate	27,650	60.6	8.9	21.3	76.2	11.3	55.8
Tailing, zinc	86,737	3.2	16.6	3.1	12.6	66.4	25.5
Tailing, quartz	17,659	1.0	6.4	1.2	0.8	5.2	2.0
Slime	25.414	9.0	14.5	7.0	10.4	17.1	16.7

The first unit of the lead-section of the selective-flotation plant operating on slime ran continuously during the half year. A portion only of the slime was treated at first, but after improvement had been perfected the total slime-product from the concentrator was handled, the result being as shown below:

Product	Net weight, tons	Assay value: Lead, %	Zinc, %	Silver, oz.	Proportion of metal content: Lead, %	Zinc, %	Silver, %
Concentrate	1,924	58.7	9.3	44.7	82.8	10.1	88.8
Residue	11,718	2.0	13.6	0.9	17.2	89.9	11.2
Total	13,642	10.0	13.0	7.1	100.0	100.0	100.0

The zinc-section of the selective flotation-plant is completed and experimental work is in progress on the residue from the lead-section. The high calcite-content has rendered it difficult to obtain satisfactory commercial results. The total costs, exclusive of selective flotation, per ton of concentrate produced, were £6 17s.4d.

GOLDFIELD CONSOLIDATED

The annual report of the Goldfield Consolidated Mines Co., for the year ended December 31, 1916, shows that 338,680 tons of ore was milled, having an average assay value of $7.52 per ton and a gross value of $2,548,425.83. The loss in tailing was 99 cents per ton, which with smelter discounts gave an actual return of $2,211,348.18. The net cost was $1,754,781.42, leaving a realization on operations of $452,734.05. Expenditure an account was $24,114.21, leaving a net realization of $428,619.84, equivalent to $1.27 per ton of ore milled. Stoping cost of ore milled was $2.56. Milling cost was $1.53 per ton of ore treated, plus 34 cents for treatment of concentrate.

NORTH STAR MINES COMPANY

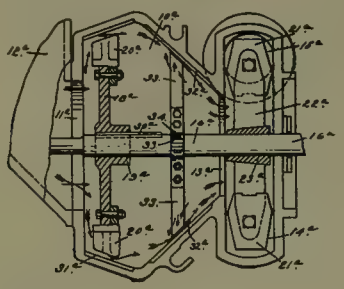
During the year 1916 the gross production of the North Star mine was $1,160,007; the expenses for current operation amounted to $613,102, and for development to $84,303, or a total outlay for operation and development of $697,405, leaving a profit of $462,602. Outlays during the year on account of improvement and property purchase amounted to $110,307, leaving a balance of $352,294. Interest and dividends on invested funds amounted to $37,755, increasing the total net earnings of the year, before deduction of allowance for depreciation and apart from the result of operations at the Champion mines, to the sum of $390,049. Dividends amounting to $300,000, 12% on the capital stock, were paid during the year. The output came chiefly from stopes above the 3000, 3400, and 4400-ft. levels. A total of 135,760 tons of rock was mined and delivered to the mills, of which 24,430 tons was sorted as waste in the sorting-plant, leaving 111,330 tons of ore crushed, with an average yield of $10.42 per ton crushed, at an average cost of $5.51 per ton for operating and $0.75 for development expenses, making an aggregate cost of $6.26 per ton crushed ($5.12 per ton mined), and leaving a realized profit of $4.16 per ton crushed. Owing to the employment of water-drills in the mine and the use of water in the process of sorting out the waste rock at the surface, the ore as milled contained about 8% of mosture, a considerably higher percentage than in previous years. It must also be noted, in a comparison of the present yield and costs per ton with those of former years, that in 1916 about 24,430 tons of rock mined as ore was discarded at the sorting plant as waste, which naturally tended to raise the yield and costs per ton crushed. Of the total production of the year, 80.78% was obtained in the mills by amalgamation, while 19.22% was recovered by cyanidation. It is estimated that the value lost in the tailing was about 35c. per (wet) ton crushed. The development work amounted to 6384 ft. (drifts 5063 ft., raises 1189 ft., winze 49 ft., and cross-cuts 83 ft.), in the course of which a total of 6826 tons of ore was produced. This work resulted in the opening of profitable ore-bodies, east and west of the shaft, and between the 2700 and 4400-ft. levels, with the addition to the ore reserves of a tonnage exceeding what was extracted from the mine during the year.

AHMEEK MINING COMPANY

The Ahmeek Mining Co. report for the year ended December 31, 1916, contains the following: Gross value of copper produced, 24,142,158 lb., sold at 25.72c. for $6,210,244.67. Silver sales, $16,503.60. Interest, $8742.72 Total income $6,235,-490.99. Running expense at the mine, $1,699,984.24. Construction account, $320,833.77; smelting, freight, commissions, and Eastern office, $764,963.46. Total expense, $2,785,781.47. Total net returns, $3,449,709.52. Four dividends were declared during the year, two of $600,000 each, and two of $800,-000 each, a total of $2,800,000. There was treated, 1,164,010 tons of ore. The cost per ton of mining, transportation, stamping, and taxes was $1.46. The operating cost per pound of production of copper was 7.04c. Other items increased the gross cost to 11.54c. From this was deducted the value of silver sold, amounting to 0.07c. per lb. of copper, making the total net cost 11.47 cents per pound.

Recent Patents

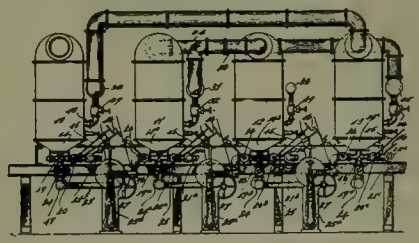
1,221,144. Pulverizing Apparatus. Joe Crites, Chicago, Ill., assignor to Raymond Brothers Impact Pulverizer Company, Chicago, Ill., a Corporation of Illinois.



1. In pulverizing apparatus, the combination of a pulverizing chamber having a discharge opening and an interior conical surface convergent toward said opening, an impact pulverizing element in said chamber which is revoluble upon and adjustable lengthwise of the axis of said conical surface, and means for producing a draft of air through said chamber longitudinally thereof and in the direction toward said opening.

2. In pulverizing apparatus, the combination of a pulverizing chamber having interior, oppositely inclined, conical surfaces, an impact pulverizing element therein which is revoluble upon and adjustable lengthwise of the axis of said conical surfaces, and means for producing a draft of air longitudinally through said chamber.

1,221,022. Method of Evaporating Aqueous Solutions. Raymond U. Bunker, Yonkers, N. Y.



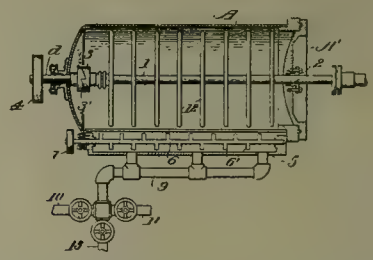
The method of evaporating aqueous solutions in a multiple effect continuous graining pan, which consists in boiling down charges of the material to be concentrated, for instance, massecuite, in the various chambers at different temperatures, passing the vapors step by step through the series of chambers, and advancing the charge from one chamber into another but into that chamber which is at the temperature to which the charge should be subjected for further concentration depending upon the existing stage of its evaporation, said vapors being passed through the chambers in such way that the last of said series of chambers in the order of advance of the charge is in a different relation to the order of progression of the vapors.

1,221,506. Process of Producing the Bicarbonate of an Alkali or Alkaline-Earth Metal. John E. Bucher, Coventry, R. I., assignor to Nitrogen Products Company, Providence, R. I.

1. An improved process for producing the bicarbonate of an alkali metal, which comprises reacting upon the chlorid of said metal with a nitrogenous acid carbonate and with an alkali metal compound containing carbon united to nitrogen by a plurality of bonds, to reform said chlorid of said metal and to form said bicarbonate and a nitrogenous compound which, at the temperature of the operation, is much more soluble than said chlorid of said metal.

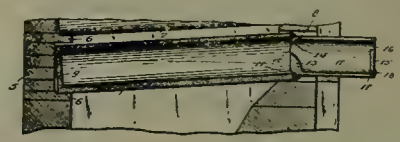
2. An improved process for producing the bicarbonate of an alkali metal, which comprises reacting upon the chlorid of said metal with a nitrogenous acid carbonate and with an alkali metal compound containing carbon united to nitrogen by a plurality of bonds, to reform said chlorid of said metal and to form said bicarbonate and a nitrogenous compound which, at the temperature of the operation, is much more soluble than said chlorid of said metal, and separating said chlorid from said soluble nitrogenous compound, in part at least, by crystallization of one of said last two mentioned substances.

1,212,932. Filtering Apparatus. Albert Legrand Genter, Salt Lake City, Utah, assignor to Kelly Filter Press Company, Salt Lake City, Utah.



In a filtering apparatus of the character described, the combination with a shell or casing and a carrier slidably mounted relatively thereto, and provided with filter leaves and a central hollow shaft which communicates with the interior of said leaves, of a driving shaft entering one end of the shell or casing, and clutch members on the opposed ends of said shafts adapted to operatively engage substantially simultaneously with the seating of the carrier within the shell or casing.

1,221,045. Conddenser for Redistilling Spelter. John G. Granberg, Beckmeyer, Ill.



In combination with a retort, a condenser having at its retort end a fixed bridge and a downturned flange arranged to prevent leakage between the abutting ends of the retort and the condenser, and said condenser having a fixed head at its drawing end provided with a drawing opening and a charging opening.

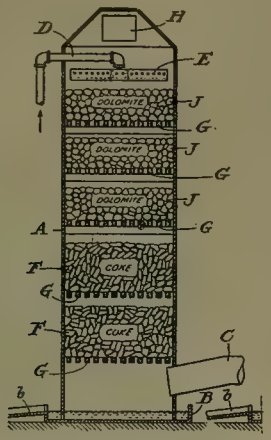
1,215,544. Process of Recovering Potassium Chlorid from Alkaline Deposits. Louis C. Jones and Fred L. Grover, Syracuse, N. Y., assignors to The Solvay Process Company, Solvay, N. Y.

1. The process of recovering potassium chlorid from alkaline brines containing sodium carbonate which consists in concentrating the brine at a high temperature, then filtering out the precipitated less soluble sodium salts leaving potassum chlorid and the boric acid content of the brine in solution and finally cooling so as to precipitate only potassium chlorid while leaving the boric acid content of the brine in solution to be subsequently recovered.

5. The process of recovering potassium chlorid from alkaline brines containing sodium carbonate which consists in heating and concentrating the brine so as to convert boric acid and boric acid salts present into more soluble sodium metaborate and precipitate less soluble sodium salts while leaving the

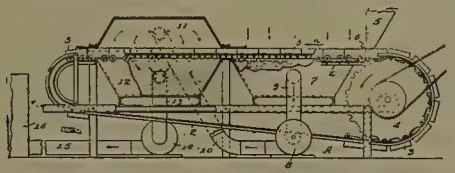
potassium content of the brine in solution and continuing the concentration until the solution is saturated with potassium chlorid at the temperature employed, removing the precipitated sodium salts and then cooling to precipitate potassium chlorid leaving sodium metaborate in solution, returning the mother liquor to the succeeding batch of brine and repeating the operation until the mother liquor approaches saturation in sodium metaborate, then precipitating sodium metaborate as borax and again returning the mother liquor to the brine to effect further recovery of potassium chlorid.

1,212,199. Method of Removing Sulfur Dioxid from Metallurgical Smoke and Similar Gases. Frederick Augustus Eustis, Milton, Mass.



The method herein described of removing sulfur dioxid from metallurgical smoke and similar gases which contain small amounts of sulfur dioxid, said method consisting in passing through a flowing body of said gases a copious flow of water containing, in solution, a material adapted to promote absorption of sulfur dioxid, said water being sufficient in quantity as compared to the volume of gas, to cause with the aid of the absorbent a physical solution of the sulfur dioxid gas in the liquid.

1,215,636. Process for Treating Ores. Arthur S. Dwight, New York, N. Y., assignor to Dwight & Lloyd Sintering Company, New York, N. Y.

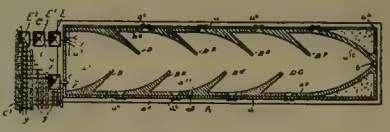


1. The herein described method of treating sulfid ore for the obtaining therefrom of gas charged highly with sulfur and simultaneously obtaining a uniformly porous sinter, the same consisting in exposing the sulfid ore in a relatively shallow layer or stratum, passing air therethrough and causing combustion therein, collecting said air after passing through the ore and while containing a relatively low percentage of sulfur, causing the said combustion to form a uniformly porous sinter body, then passing the said air with its sulfur contents again through the sintered ore and oxidizing more or less of the sulfur residue therein, charging the air volume with the sulfur gases derived therefrom.

1,208,334. Concentration of Ores. Henry Lavers, Camberwell, Henry Howard Greenway, Melbourne, and Alfred Henry Piper Lowry, Prahran, Victoria, Australia, assignors to Minerals Separation American Syndicate (1913) Limited, London, England. Original application filed Mar. 14, 1914, Serial No. 824,765. Divided and this application filed Sept. 14, 1916. Serial No. 120,057.

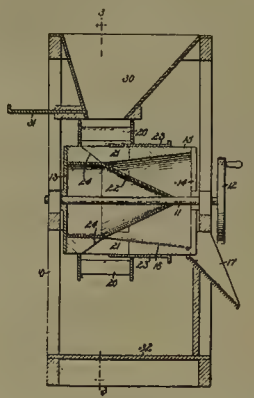
1. A process of concentrating ores which consists in agitating and aerating an ore pulp containing in solution an alkaline substance, but without the addition of a frothing agent other than the said alkaline substance, so as to obtain a froth of concentrates, and separating the froth.

1,215,672. Process for Treating Metalliferous Ores. Richard Lewis Lloyd, New York, N. Y., assignor to Dwight & Lloyd Metallurgical Company, New York, N. Y



1. The herein described process for treating metalliferous ores in fine condition, which consists in projecting a stream of the ore fines into a confined chamber, subjecting the scattered particles to a high heat thereby causing initial chemical reactions therein, then while in a highly heated and nascent state suddenly arresting said particles while being driven by the force of projection and before reaching the chamber exit and causing them to mass together to form relatively small accretional bodies wherein incipient smelting action occurs, and then collecting the said bodies in a smelting bath, substantially as set forth.

1,215,988. Ore-Sampler. Frank B. Pott, Leadville, Colo.



1. An ore sampler, comprising a revoluble drum open at one end and mounted on a horizontal axis, a cone arranged centrally within the said drum and rotatable with the same, the apex end of the cone leading to the open end of the said drum, buckets arranged peripherally on the said drum and opening onto the base end of the said cone, and means for delivering the material to be sampled into the buckets at the time the buckets reach an uppermost position, whereby a portion of the material of each bucket will slide down the cone to the open end of the drum and the portion remaining in the bucket discharged therefrom when the bucket reaches its lowermost position.

1,212,130. Flotation Process of Concentrating. Galen H. Clevenger, Palo Alto, Cal. Filed June 13, 1916. Serial No. 103,558.

1. The method of concentrating ores which consists in distilling sage and utilizing the liquid products of the distillation as flotative agents in the flotation process of concentrating ores.

2. The method of concentrating ores which consists in destructively distilling sage and utilizing the liquid products of the distillation as flotative agents in the flotation process.

Mining Decisions

Mining Claims—Meandered Boundaries

Plats and field notes referred to in patents may be resorted to for the purpose of determining the limits of the areas that passed under the patents. Reference in a patent to the mineral lot number of the claim is sufficient reference to the plat and the field notes to render them admissible to show that the lines of such claim bordering on a water front are in fact meander lines. A meander line is a line run in the survey of particular portions of the public domain bordering on a stream or other body of water, not as a boundary of the tract surveyed, but for the purpose of defining the sinuosities of the bank of a shore of the water and as a means of ascertaining the quantity of land within the surveyed area subject to sale. This rule of meander lines is applicable to mining claims abutting on a navigable body of water. Where one of the boundaries of such a claim is a navigable body of water all accretions formed after the survey and prior to entry and patent of the claim passed under the patent, and all accretions that may thereafter form become the property of the riparian proprietor.

Alaska United Gold Mining Co. *v.* Cincinnati-Alaska Mining Co. (Land Department), 45 Land Decisions, 330. April 18, 1916.

Natural Gas Contract—Construction

Held, that under a contract to purchase "Merchantable" gas from natural gas well owners, gas which gave only 500 to 550 British thermal units of heat was not "merchantable" where the standard gas sold in the same locality contained 1000 B.T.U's.

Ely *v.* Wichita Natural Gas Co. (Kansas), 161 Pacific, 649. December 9, 1916.

Railroad Grant—Mineral Exception Clause

Land upon which there is no present indication of mineral nor any geological evidence that would warrant a mineral finding, should not be held mineral in character and excepted from a railroad grant merely on the premise that future prospecting might disclose evidences of mineral.

Southern Pacific Railroad Co. (Land Department), 45 Land Decisions, 327. August 31, 1916.

Mining Regulations for Alaska

The recently amended regulations affecting mineral patents in the Territory of Alaska will be found in 45 Land Decisions, 256, under date of July 19, 1916. The Regulations governing Coal and Land leases in Alaska are published in the same volume at page 287.

Infusorial Earth Held a "Valuable" Mineral Deposit

Lands containing deposits of diatomaceous or infusorial earth in such quantity and of such quality as to be commercially valuable therefor, are mineral lands and are to be considered as excepted from railroad grants.

Central Pacific Railway Co. (Land Department), 45 Land Decisions, 223. July 13, 1916.

The Auto-Truck in Mining

Nothing has done so much to advance the development of the isolated mining regions of the West as the auto-truck. Where formerly wagons, drawn by horses and mules, moved slowly across heavy sandy roads of the desert or through the rocky mountain passes, the auto-truck now runs, dragging its trail-wagons loaded with ore, or other minerals, to the nearest railroad, or takes heavy machinery to the mines. The cost of operation is generally far below the cost of freighting by the old mule and bull-trains. The picturesque prairie-schooner with its humorously profane mule-skinner or bull-whacker has passed into history. The West owes much to them—it could never have been developed without them—but the auto-truck has displaced them, performing the service more quickly, more cheaply, and in every way more satisfactorily.

A WHITE AUTO-TRUCK CROSSING CONTINENTAL DIVIDE, IN MONTANA.

The accompanying illustration shows a White Good-Roads auto-truck hauling ore over the Continental Divide in Montana. The scene, offset by the ditch and flume, and the stumps of a de-forested area, is typical of many places in the West.

Recent Publications

Analysis of Coals Purchased by the Government in 1908 to 1915. By George S. Pope. Bureau of Mines Bull. 119. Washington, D. C., 1916.

Geology and Economic Deposits of a Part of Eastern Montana. By J. P. Rowe and R. A. Wilson. University of Montana. Pp. 60. Illustrated.

The Byron Oil and Gas Field, Big Horn County, Wyoming. By Victor Ziegler. L. W. Trumbull, State Geologist. Bulletin 14. Pp. 27. Maps and illustrations.

First Annual Report State Oil and Gas Supervisor of California for Fiscal Year 1915 and 1916. By R. P. McLaughlin. Bull. 73. State Mining Bureau of California, San Francisco, Cal., 1917.

The Geologic Formations of California. By J. P. Smith. Pp. 47. California State Mining Bureau. Price 25 cents. This little volume has been issued as Bulletin 72 of the State Mining Bureau, and is a useful contribution to the geological literature of the State of California. It contains a carefully compiled bibliography of the subject, and a brief résumé of the present knowledge of the distribution of the geological formations of the State. It has been published as a text to accompany the geological map of California, recently issued, and referred to at the time in these columns. The bulletin is sold separately.

Mining and Scientific Press

Edited by T. A. RICKARD

Volume 114
Number 18

SAN FRANCISCO, MAY 5, 1917

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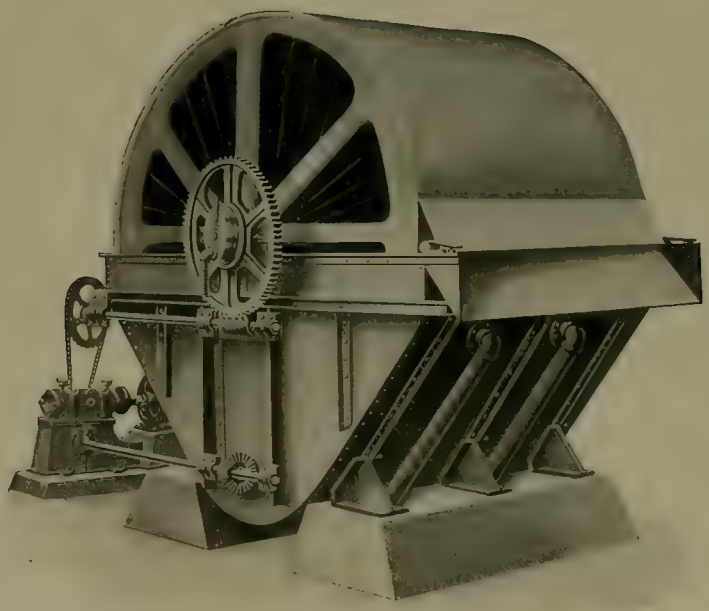

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COURTENAY DE KALB,
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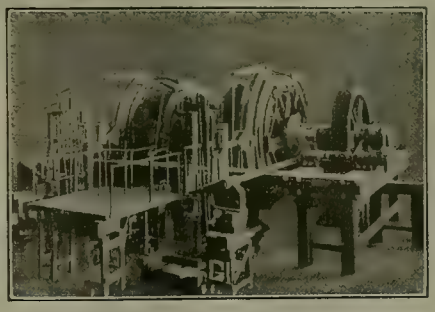
for

Furukawa & Co.

The Furukawa Mining Co., the largest copper mining company in Japan, owning some dozen copper properties and a number of silver, lead, and coal mines, as well as smelters and refineries, will shortly install a Nordberg Electric Hoist at their Ashio Mine. This is the largest of their copper properties.



The hoist is familiar in design to American engineers, being built along the Nordberg standard, particularly in regard to the construction of clutches and brakes, operating mechanism and other details. There are two drums, 10 ft. in diameter for 1800 ft. of rope. The hoist is driven by an induction motor supplied with power from an hydro-electric plant.

The long experience with Nordberg Hoists in the many great mines of the United States, convinced the Furukawa Mining Co. and their engineers of the wisdom of selecting Nordberg Machinery for their Ashio Hoist.

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NORDBERG MACHINERY

EDITORIAL

T. A. RICKARD, Editor

ACCORDING to *The Annalist*, the index-number expressing the cost of living has now risen to 270, as compared with 166 a year ago. In 1896 it was 80. Patriotism and self-interest alike call for personal thrift.

GERMAN jibes that for us this is 'a dollar war' and that we are unable to take an effective part in warfare are being answered. The whole-hearted effort now being made to assist the Allies speaks for itself; as to the naval and military participation, that will follow in due course.

LINOLEUM manufacture is just being started on the Pacific Coast by the Paraffine Paint Company. This involves an important consumption of zinc oxide and sulphate, lithophone, talc, and paris white, and is consequently of great interest to many producers of minerals and metallic salts.

JOURNALISM has found patriotic expression in a tender of service to the Government, no less than 277 technical and trade papers having offered editorial cooperation and free advertising space to support the work of the Administration in connection with the War. As would be expected, this paper is one of them.

MINES will have to do their share in finding money for the War. In the budget of the Union Government of South Africa it is proposed to impose a tax of 5% on the incomes of mining companies, together with a dividend tax of 7½% on gold and diamond companies. This taxation will replace the former 10% profit-tax, so that it does not seem inequitable.

TOYOKICHI IYENAGA, addressing the American Academy of Social and Political Science at Philadelphia on April 21, said, "The problems of a durable peace between America and Japan will not have received their definite and final solution until Japanese residing in this country receive full recognition of their political and social equality with people of other nationalities."

LAST week we referred to the dangerously deceptive character of the slogan 'Business as Usual' at this time of national crisis. We note an editorial heading in that pestilential paper *The Examiner* to the same pernicious effect. Mr. Hearst says in big type "If We Do Not Prepare for War Now by Universal Service, What Shall We Do if Real War Comes?" "Real war," forsooth; what is this if it be not a real war; is it a newspaper war to be waged by a disreputable press to fill its pages with sensational items? No, indeed, it is a stern reality; it is a war for the right to live and let live, for democratic ideals, and human freedom from an unscrupulous campaign of aggression. The United States is at war with Germany; when two such nations face each other, even with an ocean between them, it means one of the biggest and bitterest wars in history.

MR. HOOVER has given a valuable piece of advice: the centralization and co-ordination of benevolent work, for the purposes of the War, in the hands of the Red Cross. He states that the overlapping efforts, multiplication of committees, production of useless material, and the like, have led to a pitiful waste of endeavor in every European country and also in neutral territories. He advises that all local organizations should get in touch with the executive of the Red Cross immediately.

CYANIDE is being supplied from Glasgow to the Canadian mines for 15 cents per pound, according to Mr. Arthur A. Cole, the President of the Canadian Mining Institute, while on this side mining companies have to pay anything from 30 cents to $1.30 per pound. The British government made an arrangement early in the War whereby the Cassel Cyanide Company was to supply cyanide to mines within the British empire for 18 cents during the first eight months, then for a year at 16 cents, and thereafter at 15 cents per pound. Why should not our Government take similar steps to aid the mining industry of the United States by making an arrangement with the Roessler & Hasslacher Chemical Company whereby our mines also would obtain cyanide for a reasonable price. If cyanide can be supplied from Glasgow to Ontario at 15 cents, why can it not be supplied from New Jersey to Nevada and California at something like the same cost? Would it not be possible for our ally, Great Britain, to do us the favor of assisting us in this relatively small matter, by way of recognition of the solidarity of interest now subsisting between the two nations?

MANGANESE ores in 1913 sold at prices ranging from $7 to $12 per ton. The higher figure represents ores of superior purity containing about 50% of the metal. The present price for ore of equivalent grade is about $29 per ton. Owing to the decline in domestic resources attention is being directed to the recovery of the manganese in the slags from bessemer and open-hearth converters. Acid open-hearth slags contain from 3 to 21% of manganese di-oxide, and for some time such slags have been regularly sold to makers of ferro-manganese. During the War the scarcity of manganese in Sweden and Germany has led to the utilization of this

material that formerly had been neglected, the richer slags being reduced with charcoal in the electric furnace. The leaner basic slags are charged into blast-furnaces as part of the regular burden. The latter practice will probably become general in the United States, and will effect a recovery of metallic manganese estimated at nearly 30,000 tons yearly.

CHILE has threatened to levy an export duty upon copper, and Bolivia upon tin. This is an example of the familiar game of national aggrandizement. It strikes the world differently when the game is played by a small nation instead of a great one, though of course it should not. Chile is within her legal rights in seeking the main chance, but it must be followed warily. The hunter must keep to windward of the deer. Capital is timid and may take flight if bungling methods be used. Copper is not confined to Chile; the likelihood of new discoveries and fortunate development in our country has by no means passed away. It would seem that Chile had more to gain by developing domestic industry than by limiting it. Her resources are just coming to be widely known, and foreign investors have shown a willingness in recent years to undertake mammoth operations under the protection of her laws, but an export duty will deter new ventures. Even Bolivia might well consider whether the tax receipts from a constantly expanding mining industry, together with the wages paid, and the duties collected on a growing import trade, were not of more avail for purposes of revenue than an impost upon one of her principal products. By its nature an export-tax restrains foreign aid in opening a country's resources, and it either hinders the article taxed from being shipped abroad, or requires the selection of a higher grade of ore in order to meet the increased exactions of the government. At best an export-tax is unfortunate. It savors of restriction, and makes a different appeal to the imagination than a levy upon income. Unless there is a domestic demand it operates in the direction of stagnation of industry, and in both the cases cited no such internal demand exists.

CURVES of metal-prices before and during the War, plotted and published by the *Steel and Metal Digest,* tell an interesting story. The depression in the market is shown by steadily declining curves for the year preceding the outbreak of hostilities. The doleful prophesies of financial disaster, so general at that time, are reflected most conspicuously in the curves of copper and lead; copper especially plunged headlong downward. It is evident, on the other hand, that there were men in control of the other metals who had either an inspiration or a knowledge of the impending needs of a martial world. Zinc made a sharp but feeble gain in the early days of the War, as did aluminum also, while antimony and tin leaped within a week to more than double their former price. In the case of tin the cause lay in the fear that the Suez Canal might be closed, and the danger menacing vessels sailing from Nigeria and the Straits, this fear being intensified by the actual sinking of cargoes of tin concentrate by the German raider 'Emden.' Antimony was subject to frequent violent fluctuations, partly because the output is restricted and largely localized in China; the increase here was the result of a shortage of immediately available supply, due in part to the British embargo. The period of wild speculation is registered by high points on all the metal curves during the summer of 1915; since then steadying influences, indicative of a more rational commercialization of the war-demand, are conspicuous. Only copper and aluminum have shown a constant advance into the present year. Aluminum owes its position to its increased use in the manufacture of explosives, notably 'ammonal,' while the high copper prices may reflect a growing confidence on the part of the producers, stimulated by speculators, some of whom have quite freely expressed the optimistic opinion that the period of re-construction after the War would sustain demand near its present level.

An Experiment in Technical Education

Industrial mining-schools offer a solution of a pressing educational problem in this country. An innovation in providing instruction of a lower grade than that given at the universities is discussed elsewhere in this issue in an interesting and suggestive communication from Mr. Francis Church Lincoln, Director of the Mackay School of Mines at Reno, Nevada. That State has ventured to play the part of pioneer in this educational field, and the plan developed is wider than mere university-extension work. It may prove to be even wider than the sponsors of the system in Nevada have as yet undertaken to suggest. Just what it signifies is perhaps indicated by the action of the Columbia School of Mines over a year ago when the requirements for admission were raised, following the adoption of a five-year course leading to a degree. This advanced position is in harmony with the historic policy of that institution: culture, in its popular and broader sense, has not been overshadowed there by the technical requirements of the engineer. The broadly educated technologist everywhere has become foremost in his profession, whether it be mining, or chemistry, or electricity. With breadth of culture comes breadth of mental vision and such a knowledge of man as helps to the understanding of men. It gives masterful qualities that the untrained mind attains but rarely, and then only through a dominant mentality that would have lifted the individual to eminence from any station. To count upon the saving grace of native talent, to eschew the advantages of instruction in the humanities, because, in a country not yet completely emerged from its pioneer ruggedness of character, shining examples of success without these aids are still conspicuous, has long been the peculiar error of our young men, to which the universities have too readily yielded. It has been said that the American technical colleges have been turning out graduates who were neither trained engineers nor skilled artisans. This cannot be said of Columbia or of Harvard, and never will be, because they have set clearly before

themselves the ideal of being the intellectual parents of engineers destined to become the leaders of industrial development. Other mining-schools have been alert to the impending change, so that there has followed a notable stiffening of educational standards; but they have been hampered by the conditions under which the narrower training had been developed. Only a beginning has been made in the reaction against the lowered standards that began some thirty years ago, before the old academic faculties had seen how to make peace with the champions of practical science. In the struggle between 'town and gown,' the town always wins at first, but the factions ultimately discover the value of friendly co-operation. The system of industrial technical schools, now extended to embrace the field of mining, offers a convenient way out of the difficulty. The regular mining-schools have long been forced to meet the demands of young men unfortunately lacking in the fundamental necessary preparation for a sound scientific training; they have also met a demand for brief courses intended as a short-cut to jobs requiring a rudimentary knowledge of chemistry, electricity, and mechanics. The faculty of every school of this character has had occasion to blush at the discovery that these concessions had been abused by men posing as graduates after having taken no more than an elementary course of a few months' duration. The colleges have been cheapened by it and the standing of their graduates has suffered. The evil will persist as long as these shorter courses are given within the college-halls. The industrial school, however, maintained apart from the university, covers the need and does it effectively, offering the advantages to a larger number of men than can be reached by the other system, and protecting the graduated engineer from the cheapening of his diploma. Moreover, the school that is frankly technical, and nothing more, fully meets the requirements of those who are not prepared for the broader scientific and highly cultural courses. The Nevadan plan is capable of general adaptation and must commend itself to other communities.

A Captain of Industry

Some of the great mines of the world are so closely identified with the men that made them that the mine becomes a monument to the fame of the man. Thus Dolcoath unfailingly recalls Capt. Josiah Thomas, the St. John del Rey is associated with George Chalmers, and the Copper Queen with the honored name of James Douglas. Another great copper mine, the greatest copper mine developed to date, is the Utah, which similarly is linked to the name and reputation of Daniel C. Jackling. In this issue we publish an interview with that engineer, whose wealth and success have subjected him to the penalty of being labeled, in the daily press, as a 'copper king' and a 'metal magnate.' To the readers of this paper he is more than that; he is an exponent of American initiative and resourcefulness of the most effective type; he represents the man that can do big things in a big way. Looming large in the public interest he is one concerning whom our readers will like to know by what means and by what technical advantages he became prepared for his remarkable career and to what extent good fortune is responsible for his extraordinary success. Therefore we have interviewed him, asking the questions that would be likely to disclose what manner of man he is. The interview tells that unmistakably. In the first place, he emerged from an uninteresting environment, although his forebears were worthy people and of good stock; but a farm in Missouri is not an incubator congenial to engineering talent of a high order. An orphan while yet an infant, he lost something that no kind relative could replace. His schooling appears to have been of a desultory kind, and his boyhood wanting in opportunities that would be likely to prepare him to play a leading part in big affairs; however, he showed early intelligence in noting the usefulness of education and in figuring how to make enough money to be independent. That is a good democratic idea: the wish not to be dependent, to make enough money not to have to truckle to anybody, to be able to look any man in the face, and, if necessary, to tell him—what you think. His real instruction began late; he was 19 when he started to school regularly and 20 when he entered the School of Mines at Rolla. He tells us how the idea of engineering came to him while watching a surveyor at work; the precision of it captivated him. So he went to Rolla and there placed his foot on the first rung of a ladder that led to individual effectiveness. At that time he was poor, dependent on the little money earned during vacations, supplemented by such financial assistance as a kindly aunt was able to afford. He worked his way through college. That is a statement true of several distinguished engineers, for example, H. C. Hoover and F. W. Bradley. It is a fine thing to say of any man. Mr. Jackling worked on a railroad during his vacations and then won an appointment as instructor in the Missouri School of Mines, so that he was able to obtain his degree, which he did in a year less than the usual length of time. Already there was evidence of mental power; also of a restless spirit, for he changed his mind several times as to the choice of a career before he selected metallurgy. Just then Cripple Creek was on the boom; he read about it and decided to go thither. His funds were so scanty that he had to walk the last 18 miles of his journey, arriving at Cripple Creek with $3 in his pocket. There must be great satisfaction in this retrospect to a man that now could buy a railroad. Indeed the taste of poverty and the stimulus imparted by eager necessity are powerful factors in shaping strong character. An assay-office gave him his first start and a man named Staats, whom we also remember, as we do our meeting at that time with the young assayer who was destined to become the great exponent of big-scale copper mining. Then came a bit of good luck. Mr. Jackling's career was affected profoundly by the acquaintance he formed, at Cripple Creek, with Messrs. Charles M. MacNeill and Albert F. Holden. While serving his metallurgical apprenticeship at the old Lawrence mill he made friends of these resourceful

men. At that time Capt. Joseph R. De Lamar, one of the most picturesque characters in American mining, had noted the keen intelligence of the young metallurgist and asked him to make experiments on the complex ore then being mined at Mercur. That gave young Jackling the chance to investigate various processes, and prepared him for his later work at Mercur, where he won his spurs as a metallurgist. There also he got on the track of bigger game. Capt. De Lamar and Mr. MacNeill were two links in the causation that led to the Utah Copper. In 1898 the group of claims in Bingham canyon then controlled by Colonel E. A. Wall were offered to Capt. De Lamar as affording an opportunity for exploiting a large body of low-grade gold ore by cyanidation. The samples sent to Mercur showed that the gold content was less important than the copper, but the percentage of the latter was too low to be attractive at that time. However, Mr. Jackling, who had charge of the drilling of the ground, and made the necessary metallurgical tests, reported to De Lamar in 1899 that there existed an immense body of low-grade copper ore that could be exploited profitably if the operations were conducted on an adequately large scale. The spending of $3,000,000 preparatory to treating 2500 tons of 2% copper ore per day seemed, at that time, anything but attractive, even to such an enterprising man as De Lamar. So the project was dropped by him, but not by Mr. Jackling, whose ideas of opening up a big thing at Bingham were strengthened by the favorable opinion of Mr. R. C. Gemmell, who assisted him in his first examination of the property and is now the general manager of the great enterprise that resulted therefrom. But the result was not achieved either quickly or easily. Mr. Jackling went back to Colorado, being employed as consulting engineer by his old friend Mr. MacNeill, who had become associated with Messrs. Spencer Penrose and Charles L. Tutt in organizing several important metallurgical plants. By this time Mr. MacNeill had become a capitalist and had won a following among moneyed people at Boston and New York. To him Mr. Jackling brought his vision of a big copper enterprise at Bingham, supplementing his idea with facts and figures of a kind that were convincing to his friend, who knew him to be no crazy optimist but an engineer with a disciplined imagination. Through Mr. Hartwig Cohen, De Lamar's manager, Mr. Jackling was enabled at last, in 1903, to obtain an option on the property from Colonel Wall. Mr. MacNeill took the business in hand; an independent examination of the prospective mine was made by Mr. F. H. Minard; the ground was sampled on a large scale and the assays confirmed the figures obtained by Mr. Jackling himself in 1898. Thereupon enough money was raised to build an experimental plant at Bingham. On a 2% ore a 70% recovery in a 25% concentrate was obtained. The experimental mill and the preliminary operations more than paid their way, so that the mill was gradually enlarged to a daily capacity of 1000 tons. Mr. Jackling's judgment was verified, the project was placed well on its feet, the necessary capital was obtained for a steady expansion of operations, but just after the new concentrating plant, of 6000 tons capacity, was started the enterprise received a dangerous shock from the financial panic that paralyzed American industry near the end of 1907. Mr. Jackling does not say much about that in the interview, but it was a bad moment for the Utah Copper Company. A number of his associates were 'long' on large blocks of the stock and he himself was not in an invulnerable position; but he aided them and was able to protect himself, leaving a pleasant memory of forceful ability in a time of crisis and of personal loyalty to friends. That experience, and others, have established a feeling of comradeship that has proved a powerful aid to his administration of the several big enterprises of which he is the managing director. He has created an organization that is cemented by loyalty. Bluff, blunt, and big-hearted, he loves work for its own sake, he likes to be doing something interesting, he is willing to take chances, and is ambitious to wield power. Congenitally a speculator as well as an engineer, he enjoys an enviable reputation for truthfulness and for straight dealing in business transactions. To his administration of big affairs he applies a mind that is adaptable to new problems and shows ability to remember intricate details easily; and he knows when he makes a mistake—that is a saving grace lacking in many successful men. His frank acknowledgement of the miscalculation at Juneau is peculiarly instructive and disarming. He was drawn into that affair through the late Albert Holden, a daring speculator and a man of remarkable initiative. Mr. Jackling thought he could apply the big-scale copper methods to a large low-grade gold deposit, and he succeeded up to the point where one factor went wrong, namely, the estimation of the average tenor of the ore. The big sample—375,000 tons—broken in the Perseverance mine by the old company, and the milling of other large tonnages from later development-work, failed to give a true average. The yield proved less than anticipated, so that, although the estimate of cost was fully confirmed, the net result was disappointing. Mr. Jackling discusses the matter frankly and clearly. Many will find this the most interesting part of the interview. It shows that he is not so spoiled by fortune as to be unable to learn. Only 47, he will yet accomplish more. A farm-laborer at 18 and a millionaire at 40, he maintains a keen interest in the metallurgical operations by which he found a way to distinction in the profession. Today he directs the exploitation of a group of mines that will produce 600,000,000 tons of copper ore in the next 30 years. That makes the Rio Tinto and the Calumet & Hecla look small. There is much left for him to do, and in the doing of it we wish him some of the luck that every miner needs. His career testifies to the opportunities that the United States offers to the hard-working, self-reliant, keenly observant young man. His is one of those romances of industry on which we may dwell with pleasure. To other young men of this democracy it is an encouragement to work hard and to work intelligently not only, or chiefly, to make money, but to win the supreme delight of a great achievement.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Socketing a Wire-Rope

The Editor:

Sir—The first objection to John A. Roeblings' Sons Co.'s method of socketing a wire-rope, made by F. H. Mason, of San Diego, in your issue of March 31, is, I believe, without foundation. It is not necessary for the individual wires to become alloyed with the zinc. Some authorities advocate merely separating the strands of the rope after pushing it through the socket, driving wedges or taper-pins between the strands, and cementing with lead or babbit. No alloying of the lead, or babbit, and wire is supposed to occur in this method. To the second objection I will say that the amount of free acid left on the rope before the zinc is poured is necessarily negligible, otherwise the molten zinc would be blown from the socket, the action being the same as that occurring when babbit is poured into a damp bearing.

Probably more ropes break where they leave the socket than at any other point because of the sharp bending action which takes place. On account of this, and because it is hard to see the conditions of the rope just within the socket, the rope should be cut at the socket and re-socketed at regular intervals. The heat of the molten zinc may slightly anneal the wire below the socket but I cannot see how this would lessen the tensile strength of the rope. It is more likely that it presents crystallization and to some extent prevents breaking.

With the method suggested by Mr. Mason, the strain of the load would come on only a few wires as it is impossible to bend them so that they will all be drawn taut together. A few will be tight, others will rest alongside, slack.

Hammering the rope in place is objectionable, as it tends to sharpen the kink formed by bending the wire, perhaps breaking the end off.

Miami, Arizona, April 5. PHIL LAUZON.

The Editor:

Sir—The method of socketing wire-ropes given by the Roebling Co. is in my opinion the safest. I have tested eight sockets on a ½-inch (6 strands 19 wires) crucible-steel rope and I have observed tests made by the Hazard Rope Co. at Wilkesbarre, Pennsylvania. In every case the full breaking-strength of the rope was developed and the wires in the zinc cone were in no case disturbed.

In the Roebling description two important steps in the process were omitted, 'tinning' the wires and heating the socket. In order to make the method clear I shall give the whole process.

There are two kinds of sockets, the open and the closed. The open socket lends itself best to the socketing operation because after the cone is put on it can be pushed out of the socket and inspected. If the wires are spread out and then pushed up into the socket the cone cannot be pushed out of the socket unless the serving at the base of the socket is removed. A better way is to slip the socket onto the rope and serve it at a distance from the end equal to the length of the bowl of the socket.

After this is done, open the wires, straighten them, and cut out the core. Clean off the oil with gasoline. The wires must now be 'tinned,' as the expression is. Dip the opened wires in zinc chloride, and then in molten zinc. Great care should be taken that the core is not saturated with acid and the wires must be dipped in the zinc more deeply than in the acid, in order to burn off the acid. When the wires are removed from the zinc

CROSS-SECTION OF ZINC-CONE

they should be knocked against something to shake off the excess zinc. This operation of 'tinning' should be repeated until all of the wires have a coating of zinc. If they are not so coated they will not be held securely. The zinc chloride solution is made of 5 parts hydrochloric acid, 3 parts water, and enough zinc almost to consume the acid.

Now pull the rope back into the socket as far as the serving will allow. Heat the socket with a blow-torch and pour in the zinc. The zinc should be hot enough to flow freely. The socket is heated to prevent too sudden chilling. Allow it to cool for at least 10 minutes. After the cone has cooled, push it out of the socket and inspect it. If it is not a smooth job, cut it off and try it again. The cone should be as long as the socket will allow.

The accompanying photograph is a cross-section of a zinc cone that was in use while breaking a ½-inch crucible-steel rope. The black spots are the wires.

Berkeley, April 23. W. S. WEEKS.

Surface-Tension

The Editor:

Sir—I was much interested in the articles appearing in the book, 'The Flotation Process,' edited by T. A. Rickard and re-printed from your paper. I was especially interested in an article by Oliver C. Ralston entitled 'Why do Minerals Float?' on page 175 of the book to which I have referred.

Mr. Ralston, in discussing the theory of flotation, naturally has to deal with the structure of thin films and with the phenomena of surface-tension. I was much surprised, however, at two statements made by Mr. Ralston: one was to the effect that the density of the surface film of water at ordinary temperatures averages 2.14 as compared with unity for bulk-water. His second statement was a natural corollary to this, namely, that heat is liberated when a definite area of new surface film is formed, measured and found to be 0.00315 calories per square centimetre of surface. It is evident, of course, that if the density of the surface film is 2.14 times that of bulk-water, the liquid in the film must be under greater compression than the liquid in the interior and it follows that owing to the compression heat will be liberated when liquid moves from the interior to form a new surface.

Both of these statements are wrong and are easily shown to be so. Mr. Ralston made them on the authority of Dr. W. C. McC. Lewis.* He did not notice that in a later number of the *Philosophical Magazine*,† Dr. Lewis stated that he no longer regarded the views set forth in his previous paper (the one from which Mr. Ralston quotes) as at all tenable. If E represents the total energy of unit-surface, S the surface-tension, and T the absolute temperature, we have the following well-known relationship from thermo-dynamics: $E = S - T\frac{dS}{dT}$. Now the surface-tension of a liquid always decreases with a rise in temperature and therefore $\frac{dS}{dT}$ is negative and $-T\frac{dS}{dT}$ is positive. If therefore we increase the surface by unity, we do work on the surface equal to S if we keep the temperature constant. But at constant temperature the total energy of the surface is increased by E, which is greater than S by the positive quantity $-T\frac{dS}{dT}$. Accordingly, this quantity of heat must flow in from the surroundings in order to maintain the temperature constant. In other words, if heat is not allowed to flow in from the surroundings, the liquid will cool, when new surface is formed.

The above considerations imply a lower average density in the surface film than in the interior. The problem as to the variation in the density in different parts of a liquid, however, may be approached from the purely kinetic standpoint. In the interior of a liquid the forces due to the attraction of molecules will balance, since any molecule is surrounded on all sides by attracting molecules. Toward the surface, however, there will evidently be a resultant force directed toward the interior. Molecules will therefore be assisted in leaving the surface layer toward the interior and hindered from getting into the surface layer from the interior. Since in the stationary state, just as many molecules enter the surface layer as leave it per second, the density or number of molecules in unit-volume must be less in the surface layer than in the interior. If the densities were the same and still more if the density in the surface layer were greater than in the interior, more molecules would move toward the interior than toward the surface layer and the state would not be stationary.

We conclude therefore that the density of the surface film is less than the bulk of the liquid and that heat is not liberated when additional surface is formed. The surface of a liquid may in some respects behave like an 'elastic skin,' but this ought not to lead one to think that the surface film is denser than the rest of the liquid.

F. H. MACDOUGALL.

University of Minnesota, April 19.

Phil Mag. No. 20., p. 502 (1910).
†*Phil. Mag.* No. 22, p. 193 (1911).

Tin and Tungsten

The Editor:

Sir—I have been reading your valuable article in the March 31 issue regarding the production of tungsten and tin in the Black Hills of South Dakota.

Several years ago while superintendent of the Forest City Mining Co., formerly known as the Clara Belle mine, while running a drift at a depth of about 250 ft. I encountered a body of tin ore 3 ft. thick, about 15 ft. wide, and extending to view something over 100 ft., where it disappeared into the side of the drift.

Our chemist, Mr. Alfred Dany, tested several samples of the ore and it averaged 8% metallic tin. From observation made while in that country, I feel very sure that there are large deposits of tin ore around and in Oreville, Pennington county, South Dakota.

Cleveland, April 4. C. P. DOLE.

PORTLAND CEMENT testing is the subject of a recent bulletin issued by the Bureau of Standards of the Department of Commerce. It sets forth the result of several years' work of a joint commission representing the United States Government, the American Society of Civil Engineers, and the American Society for Testing Materials. It should be in the hands of all cement users.

POTASH is being produced at the Searles marsh in San Bernardino county, California, by the Pacific Coast Borax Co. in conjunction with the Solvay Process Co. The output is in the form of potassium chloride. The capacity of the plant is 1000 tons of the chloride per month.

THE REPUBLIC MILL

THE GOLDEN GATE MILL

D. C. Jackling and the Utah Copper

AN INTERVIEW. By T. A. RICKARD

Mr. Jackling, you are a Western man?

I was born in Missouri, and have lived in the West all my life.

When and where were you born?

My father and mother lived in Bates county, before there were any railroads west of St. Louis. My father was engaged in the trading and forwarding business, on the Santa Fe trail, at the old town of Hudson, near what is now Appleton City. I was born there in 1869.

Your people were of old American stock?

My mother's people were of old American stock, but my father came from England while a young man; he was naturalized in this country not long afterward; and for a time, immediately following the rush of settlers in the early 'fifties, was engaged in a small way in the shipping business of the Pacific Coast. None of his relatives came to this country so far as I know, except one sister, whom I never saw.

From what part of England did your father come?

His family lived in Lincolnshire, but he went to Liverpool while he was a boy.

That accounts for his interest in shipping?

Probably.

Will you outline your early education?

It so happened that my father died before I was a year old, and my mother before I was two years old; and as I knew nothing of the whereabouts of my father's relatives, if there were any at that time in this country, to all practical purposes I had no relatives on my father's side, so I was taken to live with a maiden aunt, my mother's sister.

What was her name?

Her name was Abigail Dunn, a good old Irish name. My father's stock was English and Scotch, his father having been an Englishman. My mother's family were originally Irish.

Please proceed with your education.

My mother's sister married a farmer. We lived on a farm during all my early life, migrating from one point to another, sometimes settling for a year or so in one place. First we went from Missouri to Arkansas; from Arkansas to Illinois; from Illinois back to Missouri, and rambled all over that country during my boyhood until the time that I first went to a little school-house near Monmouth, Illinois. I didn't start to go to school until I was old enough to walk the two miles and return alone. As I had opportunities, I went to the common district-schools during the winter, possibly half the winter, until I was about 16 years old; and then my aunt's family, with whom I lived, moved to Sedalia, Missouri. Prior to that time, I had been living on a farm in the Flint Hill country bordering the Missouri river, where picking was pretty thin.

At Sedalia, I managed to go to the public schools for two terms, and just got into the eighth grade. Part of the time I was working for my uncle as a teamster, hauling wood, on public work, hauling earth from excavations, stones for foundations, brick for buildings, and all that sort of thing, nearly always as a teamster. Then I worked out for a year on a farm at $14 a month, and commenced to save a little money. I came back and worked again for my uncle at this same sort of general work, driving a team—that was the only thing I had

ever known. After an interval I resumed work on the farm for another summer.

Had you any idea of a career?

I was then 19 years old and had made up my mind that I wanted to go to school; in fact, I got the idea of wanting something more of an education through a nephew of the man for whom I was working on the farm. The nephew was teaching in the district-school, getting $30 a month and board. He went up to St. Joseph and got a job clerking in a hardware store at $75 a month. I heard his aunt and uncle talking about how well he was doing, and I reckoned that if I could become a school-teacher I might also get to be a clerk and make $75 a month myself. I was only getting $14 a month, but saving some of that; and I figured that if I could earn $75 as a clerk, I could save at least $60 each month. Good farm-land was only $20 an acre, so I calculated I could save enough to buy three acres each month, or 36 acres a year. Eighty or 100 acres of land was a good tract, and I could see my way to agricultural independence; and agriculture was the thing I knew best.

So, what did you do?

I went back home, and got things shaped around so I could go to the State Normal school, at Warrensburg, Missouri, at the beginning of the term in September, 1888. I stayed there that year, and got along pretty well; but concluded that school-teaching wasn't exactly the thing I was looking for; and began giving considerable thought to the question of engineering.

How did that idea arise in your mind?

While teaming, I had become interested in the work of city engineering, such as laying out streets, and that sort of thing; I hadn't seen any real engineering, but the use of the transit and level captivated me; so I got it into my mind that I would like to study civil engineering. I worked again on the farm that summer, and in the autmun of 1889, when I was 20 years old, I started for the Missouri School of Mines, at Rolla, Missouri.

Were you sufficiently prepared to enter?

I was not sufficiently advanced to enter in the freshman year of any technical course, so I had to take some preparatory work, and pursue a mixed course for the first year. I didn't have any money, except what I had earned myself in these years on the farm and otherwise, but I had earned about enough to pay my first year. It didn't cost me much, because I got room and board for $12.50 a month.

In what other ways did you obtain funds?

During the summer vacations of the first and second years, I got a job on the M. K. & T. railroad, in the maintenance-of-way department, and worked in Texas, Indian Territory, and Kansas. Thus for part of the time I had to do with real construction work, building an extension of that line from Coffeyville, Kansas, into Indian Territory, now Oklahoma. I had my first real engineering experience there, and by the time I had worked my second summer, I began to get some knowledge of engineering things. I went back to school again in the fall; and the next summer, I stayed on during a summer session. In the meantime I had been appointed student-assistant to the Professor of Chemistry and Metallurgy.

What was his name?

Cuthbert P. Conrad. I think he was from Pennsylvania. Early in the following year he died, and I then had charge of the chemical department, and at the same time I was carrying on my own studies.

In which branch of engineering?

I had abandoned the civil engineering course, as my experience on the railroad did not appeal to me. I wanted to take a course in mining engineering and metallurgy, but didn't have time to do it. The metallurgical course was shorter, so I worked to the degree of Bachelor of Science in Metallurgy. According to the rules of the Missouri School of Mines, it requires some practical work before one can get the degree of Metallurgical Engineer.

In what year did you graduate?

Going unprepared in 1889, and in part earning my own way by working during my vacations and being assistant in teaching part of the time, I finished the four years' course in three years, and graduated in 1892. I did not get my engineer's degree until ten years afterward, in 1903.

What did you do then?

I stayed at the Missouri School of Mines as assistant Professor in Chemistry and Metallurgy for another year after I had graduated, and left there finally in 1893.

And you went from there to—?

I changed my mind pretty frequently. First I was going to be a school-teacher; then a civil engineer; then a mining engineer, but found my work was leading me into metallurgical studies, and lastly I was pruning again for a career of teaching. After a year of that, I concluded I didn't like it, pulled up without anything particular in view, and started out to look for a job. I went to my uncle's farm during the summer months, and tried to find a position by correspondence. I was offered a position as teacher in some of the schools, but I had decided I didn't want that; so in the autumn of 1893, I went to Kansas City. The old Kansas City Consolidated Co.'s Argentine plant was running then, and some of my friends were working there.

Whom did you meet there?

Curtis Alexander was the assayer, and I tried to get a position from him, but failed. The only thing I could get was a job pushing slag-pots. That was all right, but just about that time, Cripple Creek was beginning to attract a good deal of attention, and I decided I would go there.

Did you know anybody at Cripple Creek?

I didn't know anybody in the West at all, but I got together what few things I had and prepared to go anyway. I found I hadn't enough money to pay for a

LABORATORY IN THE ROLLA SCHOOL OF MINES. MR. JACKLING IS INDICATED BY THE ARROW

ticket, but I got a little from my aunt; she did not have much, but had always helped me some, so I borrowed enough money from her to get me to Colorado Springs. I landed there a day or two after New Years' day 1894; and went up on the Midland to Divide the next morning. There was no railroad into Cripple Creek then. I could not afford to take the stage, so I got a fellow-passenger to take my grip on the stage, and I traveled along behind on foot to Cripple Creek, walking the 18 miles.

Whom did you meet first in Cripple Creek?

I didn't meet anybody that I knew there. I had never been west of Kansas City, and didn't know a soul in Colorado. Some of the boys at the School of Mines came from Colorado, but their whereabouts were vague to me, so I was without an acquaintance in Cripple Creek.

How much of your money was left?

I had only three dollars when I got to Cripple Creek, and that didn't last very long. One couldn't buy much with three dollars in Cripple Creek at that time. I spent all my money for food and was unable to pay for a room. I went to Victor, but couldn't find anything there either, and finally wound up on top of Bull Hill, where I obtained a job bucking samples in J. C. Staats' assay-office, near the old Pharmacist mine. That was early in January, 1894.

So that was your first work in mining?

Yes. I worked for Staats for a while, and when he wanted to go away for two or three months, I ran his business. I did well; it paid very nicely. In the meantime, the first Cripple Creek strike came on. By that time I had located some people I knew. One of them was F. N. Flynn, who had been an undergraduate student with me at the School of Mines. Later on, when Staats came back and took his business, I went to work in a shaft on the old Lottie Gibson, but only worked there a short time.

D. C. JACKLING, F. G. JANNEY, AND G. O. BRADLEY, AT MERCUR IN 1898

And what was your next step?

In the meantime Ed. Holden, Charlie MacNeill, George Pierce (of the Golden Fleece mine), and Captain De Lamar had organized a company for starting the first barrel-chlorination plant in Colorado, and were about to rehabilitate an old stamp-mill some little distance below Victor, known as the Lawrence plant. I had heard of this scheme and had talked to Staats about it. He telephoned to Charlie MacNeill for me. Charlie was secretary of the company. I went down there to get a job, and bumped into Ed. Holden, who was running the business as the chief executive. Dawson Hawkins was superintendent. I saw them start on practically the first reconstruction of that old plant, which proved to be the one in which the chlorination process that took so much gold out of the Cripple Creek ores was developed. Chlorination was ahead of cyanidation. John E. Rothwell was there part of the time. He had been engaged as consulting engineer, and had come down from the Golden Reward, in the Black Hills, where he had been putting in a barrel-chlorination plant.

What appointment did you obtain?

I started to work at the Lawrence plant as assayer, and, as time went on, got more deeply into the technical department, and pretty soon I was doing all the chemical work. Finally the chiefs of the metallurgical department, Rothwell, Hawkins, and all the rest of them, went away, and I was the chemist and metallurgist for the plant.

That must have been in 1894, for I remember examining the Elkton and going down to the Lawrence plant with Dawson Hawkins, who introduced us. Do you remember?

Yes, I do. That was in the fall of 1894. I stayed there until the latter part of 1895, when the plant burned down.

But chlorination had won a foot-hold, had it not?

Out of the Lawrence experience grew the MacNeill and Penrose installations at Colorado City. The Gillette plant, a small chlorination mill, was built in the meantime at Grassy by Ned Hawkins, a brother of Dawson Hawkins. Dawson had left Lawrence, as I have said, and I don't know but what he was associated with his brother Ned for a while in building this Gillette plant.

After the Lawrence plant was destroyed, MacNeill got together another organization, using the data from the Lawrence experience, and organized the Colorado-Philadelphia Reduction Co., which built what was called the Colorado plant. That was the first big chlorination plant in Colorado, and was at Colorado City. Later they built a still larger plant, called the Standard, also at Colorado City.

In the meantime, Argall had built his Metallic Extraction cyanide plant at Florence; and then others followed. The whole metallurgical trend for Cripple Creek ores, outside of Argall's work, was toward chlorination. The National mill was built at Florence, and was a good-sized plant; the Union, which was a very large plant, was also built there; and about the same time the Portland mill was built. The Lawrence mill was the nucleus from which grew the reduction works that for a great many years treated nearly all of the Cripple Creek output. Argall's plant was closed down when the United States Refining & Reduction Co. was organized, but he lived to see his ideas re-established, although along somewhat different lines.

The burning of the Lawrence plant was the end of my experience in the Cripple Creek district. I then made some examinations for Captain De Lamar, who owned a large interest in this Lawrence plant, but he did not go into the Colorado City enterprise. In the meantime De Lamar had become interested in the Mercur district, Utah, and had organized a company called De Lamar's Mercur Mines.

But this enterprise did not include a chlorination mill?

No. The old Mercur Gold Mining Co. was the first in the country that had employed the cyanide process successfully, and upon a considerable scale. It had used it on the oxidized ores of the upper zones. The mines controlled by Captain De Lamar lay in a lower geological topographical horizon; and a large part—the most important portion—of their orebodies was non-oxidized ore that was not amenable to any known method of treatment in their natural state, on account of base sulphides of various kinds. There was almost everything that one could imagine, but the principal refractory constituents were mispickel, the arsenide of iron, and the two arsenides of sulphur, realgar and orpiment.

Did you discover a way of treating this ore?

Captain De Lamar acquired these interests in 1895, or about that time, and during that year sent considerable quantities of these ores over to me for experiments at the Lawrence plant. I thought there was a way out of the difficulty in treating them; very few others did. He had sent samples to Europe and elsewhere, and the metallurgists had all reported that there was no method applicable to that low-grade refractory ore. I had made some experiments in Colorado, and thought something could be done. At the same time, I had conducted a series of experiments on the ore of the Jim Crow and Monitor mines, which formed the basis of De Lamar's Nevada property, not far from Milford. Early in the year 1896, De Lamar engaged me to go to Mercur and commence more extensive experiments, on my representation to him that I had obtained some results that were promising, and that I believed offered a solution of his problem.

What men were there at that time?

George H. Robinson was manager of the De Lamar Mines then; and R. H. Terhune, of the old Hanauer smelter at Salt Lake City, had been engaged as metallurgist to advise him about some method of treatment; but nothing had been done at all. I took hold of the research and worked with Terhune. After a little while, he dropped out, and I was authorized to build an experi-

THE GOLDEN GATE MILL AT MERCUR, IN 1898

mental plant. In two or three months, in May or June, 1896, we had the little plant ready, and commenced operating on a small scale, a few tons a week, getting good results. I carried the experiments through until late in that year, and got definite and satisfactory results, which I believe were among the first, if not the first, based upon the roasting of ores for cyanide treatment anywhere in the world. Argall may have done it at Florence before; but the work at Mercur was the basis of the first big installation of a cyanide plant that contemplated the roasting of ores before cyanidation.

What were your difficulties?

We had a problem more serious than the elimination of the sulphur; and that was the lime and clay base of the ore which formed naturally a good cement-making product; so that after we roasted the ore and put it into vats to leach, we found it setting into masses of solid concrete. We had that to overcome, but we did overcome it by carefully wetting, mixing, and seasoning the ore before charging it into leaching-tanks. At the end of that year, we commenced designing a 500-ton plant.

What other innovations do you recall?

That experimental plant was, so far as I know, the first place in the country where powdered zinc was used as a precipitant for cyanide solutions on a commercial scale. C. W. Merrill came there with Henry Bratnober and others in the autumn of 1896 to examine the mines, and I believe Merrill saw there the use of zinc-dust for precipitation on a commercial scale for the first time. I used it in the old way—adding it direct to the solution-tanks and agitating with air. In the meantime, between the operation of this experimental plant and the construction of the first section of the De Lamar Mercur Mines mill, the De Lamar Nevada Mines had changed their process from chlorination to cyanide, and there used on a large scale zinc-dust precipitation before we used it on a similar scale at Mercur; but the application of it on a working scale was elaborated in the little experimental plant at Mercur.

Early in our use of zinc-dust, we found that certain kinds didn't give as satisfactory results as other kinds, and by analysis I determined that the amount of impurities had a marked effect, and found that the purer dust didn't work so well as that which was less pure and contained some considerable percentages of lead; so I corrected the defect in the purer dust, so far as I know for the first time, by adding a solution of lead acetate to the precipitation-vats. I believe that sodium cyanide was used in this mill at Mercur for the first time, on a large scale.

In what year was that?

We started to build a 500-ton plant at Mercur in the summer of 1897, commencing on the foundations in June of that year; and in April, 1898, we ran the first ore through it, having built the first all-steel mill in the West; and having employed in a large way, for the first time, electric current transmitted at 40,000 volts for milling purposes, using the induction-motor. L. L. Nunn built the Telluride power-plant at Provo, and had introduced these improvements in a small way in Colorado, but we took this power at 40,000 volts and had the first large installation served by high-potentional transmission in America, I think—in the Golden Gate mill at Mercur. Anyhow, so far as I know, we used for metallurgical purposes of that kind, and on a considerable scale, the first induction-motors to be so used. We had a good deal of trouble in starting up that plant; we had introduced so many new devices. There was some trouble

with the power; and we found that the roasting-furnaces were not particularly well adapted, and had to design our own furnaces.

What furnaces were you using?

Horace F. Brown, the straight-line roaster. We had a double problem, one of roasting and one of cooling. The Brown did the roasting, but we had to combine cooling and spraying to get the product in proper condition to put in the vats. One of the methods for overcoming the 'setting' of the cement-like material produced by roasting was to spray the ore with water while it underwent stirring and cooling, and thus allow it to agglomerate and set in small granules, which were sufficiently porous for good leaching. We further overcame the 'setting' by mixing with the roasted ores a certain percentage of oxidized ores that did not need roasting and only required comparatively coarse crushing, so we finally got a product that would leach satisfactorily and could be removed from the vats without difficulty.

What furnaces did you use then?

We remodeled the Brown furnaces and got them to working fairly well, employing for the first time, so far as I know, the top of the furnace for a cooling-hearth. We sprayed water on that, and got a satisfactory product. We then designed a furnace of our own that was called the Jackling furnace. It was designed not because I had any ambition to invent a new apparatus to bear my name, but to meet a necessity. In the meantime we had put in some Holthoff-Wethey furnaces. We started with four furnaces only of the Brown type, later adding two of the Holthoff-Wethey type, and then three of the so-called Jackling type.

Who was manager of the Golden Gate mine at that time?

In the meantime, George H. Robinson had resigned, and H. A. Cohen became general manager, and he in turn was succeeded by Victor Clement. Duncan MacVichie was superintendent of the underground operations and I was superintendent of the surface operations.

We employed there, I think for the first time, a large-capacity induction-motor electric hoist. This hoist was controlled by friction-clutches and reversing-gears between the motor and the drum.

Won't you say something about the first use of sodium cyanide?

I found we had so many acid salts, which we were pleased to call 'cyanicides' at that time, that the consumption of cyanide was very high. Potassium cyanide pretty nearly all came from across the water, and was expensive. In order to overcome these cyanicides, we bought soda-ash as a neutralizer, and used that in making up stock solutions before adding cyanide. The first observation that suggested the use of sodium cyanide was due to our having received a lot of potassium cyanide that was very impure, and the question was raised as to whether or not that was as valuable as the purer potassium cyanide. I reasoned that if I had a solution of alkaline cyanides with a very large quantity of caustic soda present, I didn't know whether I had potassium or sodium cyanide and, as a matter of fact, sodium having a lower equivalent, that if we used more of the sodium cyanide, we would have more of the active agent cyanogen present per unit of chemical. Thus it developed that sodium cyanide was just as good for us, and we gradually changed from the use of potassium cyanide, which was expensive, to sodium cyanide, which was much cheaper.

So you began to do good work?

We got that plant into very successful operation, and up to its full tonnage about the end of the year 1898, and began enlarging it; and those enlargements were in part completed, and in part under way, when I resigned in December 1899.

Who succeeded you?

When I left Mercur, I turned the operation of the plant over to F. G. Janney, who became superintendent of the mill. Janney theretofore had been my assistant, practically since the beginning of the construction of the plant in 1897. That was my first association with Janney.

You went to Salt Lake?

No. Clement had resigned; and I went at his suggestion as consulting engineer to design a mill and process for some mines at Republic, Washington. Clement had known something about these mines, and thought they had pretty good prospects.

Was Clement connected with these mines at Republic?

No, but his friends Volney Williamson and Patsy Clark, of Spokane, were. However, before I went there, they had sold out the larger part, if not all, of their interests in the Republic mines to some Canadian people, Clarence McCuaig and other capitalists. I was employed by McCuaig and A. A. Ayer, of Montreal, to go to Republic and design a bigger plant than the one they had there, and a more economical one, which I did. Up to that time, they had been using a small mill, employing the Peletan-Clerici process. I sent my metallurgist, Herbert Fox, to Republic in the latter part of 1899, and he worked out most of the metallurgical data, so that when I went there in 1900, we were pretty well prepared to go ahead. We built a 250-ton mill that year, and started it in the winter, running it the better part of the next year. It did economical work and made good recoveries, but the ore developments and reserves were not up to expectations, so the mill had to close down late in 1901.

What did you do then?

I went back to Colorado again as consulting engineer for the United States Reduction & Refining Co. under engagement by my old friend MacNeill.

You mean consulting metallurgist?

No, the title was consulting engineer. I was getting out of the technical metallurgy and more into engineering and construction lines.

As I have said, I went back to Colorado, and about that time, the U. S. Reduction & Refining Co. had its

THE UTAH COPPER HILL IN 1904

attention drawn to the utilization of low-grade lead and zinc ores, more particularly from the Leadville district, as employed in making zinc-lead pigment at Canon City; and they sent me there to look into F. L. Bartlett's plant. The result of that examination was that the U. S. Reduction & Refining Co. purchased the Canon City pigment plant, and sent me to re-build and operate it. I stayed there during 1902 and 1903, and we developed the business to a profitable condition. It would have continued to be profitable for a long time but for the fact that metallurgy was developing more rapidly in other lines.

To what do you refer?

The electro-magnetic separation of zinc and lead ores had commenced to interest people in the West; instead of the Canon City plant being able to get such ores practically on a lead-smelter basis, whereby they paid for the lead while the zinc was penalized, it found itself having to compete with people not only willing to take mixed ores without penalizing them, but beginning

THE UTAH COPPER HILL IN 1914

to pay something for the zinc, using the Wetherill process. The Empire Zinc Co. in the meantime had built an experimental plant at Canon City and was buying ores; and other plants grew up in Colorado of a similar kind, or at least designed to do the same thing, so that eventually they put the Canon City pigment plant out of business—but not until some time after I had left it.

Where did you go?

In the autumn of 1903, I was called back by De Lamar to Salt Lake to attend a suit over the interpretation of an electric-power contract we had made with the Telluride Power Transmission Co. while I was superintendent of the plant at Mercur. This suit kept me in Salt Lake City for about two months, or until the beginning of 1904.

Here I must break the story, and go back to 1898 and 1899, when I was still at Mercur. Captain De Lamar had his attention called at that time to the Wall group of claims, which constitutes a part of the present holdings of the Utah Copper Co., in Bingham Canyon, and which formed the initial basis of that company's organization. These claims had attracted the attention of Captain De Lamar's engineers while working under the management of both Cohen and Clement. About that time, and following the success of the cyanide process at Mercur, a good deal of attention was being given to some low-grade gold-ore deposits, mostly in the form of gossans, or outcrops, in the Bingham district.

The old Stewart mine, which was the nucleus of what was later the Boston Consolidated group, had been first worked for gold. In the meantime Thomas Weir had built a cyanide plant to treat some surface gold ores on the Highland Boy group, which later became known as the Utah Consolidated. Others had begun experimental operations, at least, on similar ores on some of the claims that now form a part of the United States Mining Co.'s holdings, the old Telegraph and Niagara.

The Wall group was first sampled by De Lamar's representatives with a view to determining whether or not the ore also contained enough gold to make it profitable.

By cyanidation?

Yes. The samples that were taken in 1898 were sent to Mercur for assay, and it was found that there was no considerable quantity of ore containing commercial values in gold; but it was recognized at the same time that a very large quantity of ore did exist containing about 2% copper, and in some places better than that.

Recognized by whom?

It was self-evident.

But ore of that low tenor was hardly interesting at that time?

That will develop. I was sent to Bingham about the end of 1898 to take charge of some development work and make a report on the possibility of handling these low-grade copper ores at a profit. I believe the first churn-drilling for the purpose of testing copper orebodies was done at Bingham at that time, when two churn-drill holes were driven to a depth of several hundred feet. We started, in addition to the drilling, to do some tunneling, and drove several hundred feet at various places into the hillsides.

We re-modeled an old five-stamp mill that was on the ground and had been used in the early days as a gold mill, and crushed several hundred tons of the ore as we took it from the tunnels, concentrating it on Wilfley tables and vanners. We shipped the concentrate to the old Germania smelter near Salt Lake, and I made a report to Captain De Lamar in the summer of 1899 in which I expressed the belief, based upon my investigations, that there was not only a very large quantity of ore that would average 2% copper, but that it could be worked profitably on a large scale.

R. C. Gemmell had for a long time been associated with the Mercur operations as the chief mining engineer, and he assisted me in making that part of the report pertaining to the development of the orebodies and the probable amount of tonnage. We calculated at that time there was definitely demonstrated not less than 9,000,000 tons of ore that would run something better than 2%; and we expressed it as our view that additional development work would result in proving not less than 25,000,000 tons of similar ore.

The report I made to Captain De Lamar contemplated the same general plan of operation that is now employed. I recommended building a plant at what was known as Adamson Springs, not far from the shores of Great Salt lake, and on precisely the same site that the Magna plant of the Utah Copper Co. now occupies. This recommendation was made because there was neither water-supply nor available room for the storage of tailing in the vicinity of Bingham, and the site selected provided ample facilities in both respects.

Captain De Lamar, for various reasons, principally, I believe, the large amount of money that was involved in putting the proposition on a profitable basis, did not look with favor upon it.

What was the price of the mine?

Captain De Lamar had paid $50,000 for a one-fourth interest when he started to develop; he had an option to buy other interests, the terms of which I do not recall now. He had agreed to spend an additional amount in development. The total expenditures in purchase and development made by Captain De Lamar amounted to something less than $100,000. He dropped the proposition, but had acquired a one-fourth interest in the property.

How much money did you estimate would be required to put the enterprise on a profitable footing?

Several million dollars to build a railroad and put the thing on a profitable basis. I recommended an initial operation of 2500 tons per day; that seemed a tremendous figure at that time. Of course, I had in mind an increase of tonnage later, but 2500 tons per day was to be the scope of our operations at the start.

You don't remember the amount of money you estimated to be necessary?

It wasn't very definite, but, roughly speaking, it would have required around $3,000,000.

The matter was dropped, and I then went to Republic, Washington; but I kept the idea in mind, and called the possibilities of the proposition to the attention of several men who were interested in the copper industry. During the next three years, I lost no opportunity of interesting people who had the money and were familiar with the industry in a proposition that I thought offered the biggest opportunity I had ever seen.

You did not succeed at first?

When I went back to Salt Lake in the winter of 1903, I endeavored to secure an option from Colonel Wall on the property, believing that I could interest my associates in the United States Reduction & Refining Co., Messrs. MacNeill, Penrose, and Tutt. Colonel Wall declined to give me an option, saying he had a tentative option out on the property at that time, but that he had little hope of anything being done, and believed the time was not right to dispose of the property to good advantage. He expressed the belief that it would ultimately be valuable, but thought the value was a prospective, rather than a present, one. H. A. Cohen, De Lamar's former manager, was present in Salt Lake City in connection with the power litigation; and I again discussed the matter with him, and told him that if he could secure an option, I believed I could interest my associates in Colorado to an extent that would induce them to provide the money necessary to demonstrate the proposition, at least on a moderate scale. Cohen went to Colonel Wall and succeeded in getting an option on 80% of his 75% interest, or 55% of the property.

I took the option to Colorado, and presented it to MacNeill, who, after some hesitation, interested himself to the extent of sending an engineer, selected by R. A. F. Penrose, to go over the property, and sample it, as Gemmell had done in 1898 and 1899.

Who was the engineer?

F. H. Minard. This sampling verified all of my representations and Gemmell's as recorded in our joint report, both as to grade of ore and prospective tonnage; but Mr. Minard expressed the view that more preliminary metallurgical experimentation should be conducted before the proposition would warrant the expenditure of sufficient money to develop and equip it to the extent of a commercial operation. All of the samples, amounting to several tons, were shipped in duplicate to Canon City and to Colorado Springs; and, after verifying the assays, the rejections were gathered together and sent to the Colorado plant, at Colorado City, where they were ground in sampling machinery for a small concentrating test, which verified in every way the results I had obtained in the operation of the little mill in Bingham Canyon in 1898 and 1899.

THE UTAH COPPER GROUND AND D. C. JACKLING'S EXPERIMENTAL MILL IN 1898

So your friends were willing to go ahead?

Yes. Mr. MacNeill and his associates decided that the proposition warranted the necessary expenditure to determine whether or not the operation could be made profitable in a comparatively small way, and correspondingly more profitable in a larger way; so a small exploitation company was organized to build a mill in Bingham Canyon. We styled it an experimental plant.

This mill was designed for a capacity of 300 tons per day. Construction began in August 1903, and we ran the first ore through the plant in April 1904. The first step toward opening the mine for actual production was taken in November 1903, in starting what was known as the old 'main tunnel.' The plant started up, as stated, in April 1904, but did not develop its full capacity of 300 tons per day for nearly a year.

You might say something about the recoveries, if you can.

From the start, the recoveries verified the preliminary results that had been obtained a few years before, and the plant actually made a profit every month from the day it started.

You don't remember any of the percentages?

We were running on an ore averaging about 2%, and were recovering a little less than 70% of the total copper in a concentrate averaging around 25%. The plant having demonstrated that the mine could be profitably operated, we began making plans for a larger installation at Garfield.

In the meantime, Captain De Lamar's one-fourth interest had been purchased, thereby giving the Utah Copper Co. (of Colorado) an 80% interest in the property; and a new company was formed which took over the original Utah Copper Co.'s 80% and Colonel Wall's 20%, in consideration of stock interests in the new company, which was then called the Utah Copper Co.—the same name, only the original corporation was registered in Colorado, and the new company in New Jersey.

The Copperton plant, as the Bingham Canyon plant was called, was gradually increased until it eventually reached a capacity of 1000 tons per day before it was finally closed-down, after the Magna plant at Garfield had been in operation for some time.

The designs for the Garfield plant, which was to have a capacity of 3000 tons per day, were completed in 1905, and we commenced work on the foundations in the autumn of that year. Legal and other complications, however, made it necessary to discontinue construction work for some time. Wall had brought an injunction suit. The money for the construction of the Garfield plant was provided through the sale of $3,000,000 of convertible bonds, most of these being taken by the Messrs. Guggenheim.

Was that the firm of M. Guggenheim's Sons?

No, the Guggenheim Exploration Co. Early in 1906, work was again actively started. In the meantime, it had been decided to build the Magna plant for a capacity of 6000 tons per day, instead of 3000 tons, that is, a plant of twelve sections instead of six sections; and it is interesting to remember that the 12-section plant then started provided the same identical buildings that are now accommodating, and in which for long periods last year we averaged, better than 20,000 tons per day. At that time I reckoned that a 'section,' as we designated it, of the mill would have a capacity of 500 tons per day. With the same grinding machinery that we then installed, we now grind regularly more than 1500 tons per day in excess of the 12 sections.

Was this due to 'speeding up' the machinery?

Yes, and better methods of operation—more method than speed, in improving the operation of rolls and Chilean mills. We are not grinding as fine now as we did then.

You are not grinding as fine now?

No, we cannot grind as fine on the large tonnage we are now handling, but we are preparing to grind finer by aid of heavier and additional machinery, taking advantage of the tremendous improvements in methods of milling that we and others have developed.

The first section of the Magna plant started in the spring of 1907.

That was the year of the panic?

The bad times came in November, when we were just beginning to get well started; but nevertheless we were able to increase tonnage continuously. I can't say when we got up to the originally contemplated 6000 tons, but we didn't do it for over a year.

Getting back to the mine—at the same time we started to build the Garfield plant, we began to figure out the ultimate plan of mining, which contemplated the use of steam-shovels; and the first steam-shovel was put on the property in 1906, after Mr. Gemmell, who was then general superintendent, had gone with me over the most important steam-shovel operations in the United States, more particularly in the iron regions. W. C. Agnew, the general manager of the Mahoning iron mine, came out and made a report. He advised us not to attempt steam-shoveling exclusively, as the country was too rough and we never could get elbow-room; he recommended underground mining or 'glory-holing.' I believe he was then recognized as one of the best steam-shovel experts in this country. He said it was not a good steam-shovel proposition, but nevertheless gave us some most valuable advice. We were working all the time in the face of adverse opinions of nearly everybody; nobody thought much of the schemes that we knew we had to employ to make the operation a success.

The development of the mines and their metallurgy from this time forward are well known history.

In 1910, the Utah Copper Company acquired the property of its neighbor, the Boston Consolidated Co., which in the meantime had also constructed a 3000-ton plant at Garfield.

Which is that, the Arthur plant?

Yes, the Arthur plant, which now, under the same roof, has a maximum capacity of more than 15,000 tons per day. The Magna and Arthur plants combined, during the last quarter of last year, treated at times as high as 40,000 tons per day, and averaged during several months last year more than a million tons per month. You know as much about the rest of the history of the Utah Copper Co. as I do.

I know that it led you to go farther afield.

Yes, while we were developing the Utah Copper, we began to investigate other deposits of a similar kind. The first of these was what is now known as the Nevada Consolidated, of which property the Utah Copper Co. acquired control in 1910, simultaneously with its purchase of the Boston Consolidated property. A large part of the data upon which the Nevada Consolidated enterprise was founded was derived from results of operations in Utah; and when the Messrs. Guggenheim acquired control of the Nevada property, before it was thoroughly developed and before construction began on the plants at McGill, I was consulted regarding the location of the plants and the design of them.

The next property to attract the attention of my friends and myself was the group of mines at Ray, Arizona, now known as the Ray Consolidated. Options were taken on that in 1906, and some exploration by shaft was started. The panic of 1907 delayed developments, which, however, were taken up again late in that year; and the property was finally developed and equipped under my direction.

The Ray was worked unsuccessfully by Alexander Hill, was it not?

Alexander Hill reported on it, but, I believe, it wasn't worked under his direction. Ray had been worked in the 'eighties in a very small way, on some stringers, under much the same conception as some of the property of the Utah Copper had attracted attention in the early days, which resulted in the driving of several tunnels on rich streaks. Later, in 1896 or 1897, an English company built a mill at Kelvin and started to operate; but there was no railroad at hand, and they had based their operations on 4 or 5% ore, which they didn't have in anything but limited quantities.

And then they did not know how to treat the chalcocite?

If they had had 5% ore they would have gotten along all right, but the 2%, of which they had considerable quantities, didn't make both ends meet, and that resulted in failure, so the property lay idle. That was in the late '90s. Between that time and 1906, the Arizona Eastern railway had been built into Kelvin, and a few miles beyond. While Ray was under development, the old Santa Rita mines were brought to the attention of Messrs. Hayden, Stone & Co. by Thomas W. Lawson, A. C. Burrage, and H. H. Rogers, just before Mr. Rogers died. These properties were acquired, and the Chino Copper Co. was formed, that likewise being developed and equipped under my personal direction.

In 1912, the Butte & Superior property also attracted the attention of Messrs. Hayden, Stone & Co. I visited the mines in July 1912 and found that while only relatively small orebodies had been developed, the promise of a much larger one was great. I outlined a plan of development to be pursued for the remainder of that year, and this having fulfilled my expectations, I advised Messrs. Hayden, Stone & Co., in January 1913 to finance the properties for larger operations.

And you, yourself, became interested in them?

Yes, I was interested in all these enterprises, and have always retained as large interests in them as my means would permit.

And you acted as consulting engineer?

I was vice-president and general manager of all of the companies until I relinquished the general manager's title to the local managers, and took to myself that of managing director.

When you went to Butte at that time, you probably had your first glimpse of flotation?

Yes, it was the first I knew about it in practical operation; and the flotation process in its commercial application in a large way in this country was developed by the Butte & Superior Co., under the direction of my engineers.

Which engineers?

Frank Janney, and Frank Janney, Jr., and other engineers that came out of my organization, principally from the Utah Copper Company.

So the Utah Copper in the end was an important factor in flotation?

The general staff operating all these properties was the developing medium for the flotation process.

Will you speak of your Alaskan venture?

In 1911, A. F. Holden and his associates brought to the attention of Hayden, Stone & Co. the Alaska Gastineau mines at Juneau. In 1912, in company with Holden, I visited these properties, and stated my belief that the large deposits of low-grade gold ore there justified development and equipment, which was done; the metallurgical problems and plant-design being worked out by the same engineering staff that had to do with the equipment and metallurgy of all of the 'porphyry' properties and the Butte & Superior; and the mine development and equipment being worked out by the men whom we found in charge of the Alaska Gastineau mines when we became interested.

Who would those be?

B. L. Thane and Whipple, his assistant. Thane was the man who was responsible for the mining operations.

You have had some trouble owing to admixture of waste-rock?

As a matter of fact, the actual trouble we have experienced was that in parts of the mine, which according to all development records should have yielded a certain grade of ore, it was found when we came to mine it, that the grade wasn't there, and isn't now.

To what extent, Mr. Jackling, do you believe that large bodies of such low-grade ore can be sampled?

Large bodies of the kind of ore that we have in the 'porphyry' deposits, and located as these deposits are, can be thoroughly sampled at reasonable expense, because we can drill them; but large bodies of very low-grade ore, and particularly gold ore, such as those of the Juneau properties, cannot be satisfactorily sampled. We have learned that they cannot be tested within the

PANORAMIC VIEW OF THE TERRACED EXCAVATIONS MADE BY STEAM-SHOVELS ON THE PROPERTY OF THE UTAH COPPER COMPANY AS SEEN
MATERIAL REMOVED, 66,000,000 CUBIC YARDS, CONSISTING OF

limits of reasonable expense for development, and with any satisfactory degree of accuracy compared with ordinary deposits.

You agree, then, that we cannot find out how many raisins there are in the cake, except by eating a large portion of the cake?

That is the answer as to a deposit like that exploited by the Alaska Gold Mines. You must mine a large tonnage and mill it and get your result in order to know what the grade of your ore is. The proportion of gold is so small that a few cents per ton—what would be a negligible amount in ordinary ore—makes a vital difference in such low-grade ore; and our experience in Alaska indicates that sampling from development almost invariably shows results higher than they should be. The difference isn't much, only 30 or 40 cents per ton, but that much where the profits were expected to be only 50 or 75 cents per ton is a serious matter.

It is a fact that we know now a thing we didn't know; we had no means of knowing, and no reason to expect before operating the mines, that the grade of ore is quite a few cents a ton less than we thought it was—enough less to make a very important difference. We had a record of milling several hundred thousand tons of ore from a large section of those mines, and this showed the grade of that section to compare closely with our development-grades around it; but it didn't work out that way, and it is apparent now that the section from which the early mining was done, notwithstanding it was not selected—it couldn't have been selected—was a better-grade area than other areas in the development of which the grade appeared to be just as good.

You applied the copper methods of concentration?

Yes, we abandoned in Alaska, as we did in the Boston Consolidated mill, the appliances we thought were obsolete, namely, stamps. We employed rolls and tube-mills in Alaska for fine-grinding and concentration, rather than amalgamation. Our costs are less and our recoveries better than we estimated. There was no error in anything we could demonstrate; we did it on a large scale and the results have proved that we were right. We didn't know so well what was underground; but the best data we could get appeared entirely satisfactory until we began to mine a large tonnage.

Owing to the enormous tonnage of low-grade copper ore at the mines under your control, you are, of course, vitally interested in the flotation litigation?

Naturally so, because flotation has proved the most effective means that we have been able to find to make greater recoveries within the limits of reasonable cost from the finest class of material, which has always been the most troublesome material in concentrating-mills. I don't think flotation is a panacea for all ores; and in the development of a new 'porphyry,' or any other kind of mine having ores which contain sulphides, I wouldn't abandon the old metallurgical methods by any manner of means. I would continue the use of what I have been pleased to call step-grinding and fractional concentration, getting out as much of the mineral in coarse sizes as possible before grinding finer, getting it cheaper than by flotation, because those are simple operations, mostly mechanical, and can be readily observed, making products better adapted to smelting and easier to handle; then use the flotation process as an adjunct or auxiliary to do better with the very fine products than we can do by any other means at permissible costs.

IN 1917. TOTAL VERTICAL HEIGHT FROM BOTTOM LEVEL TO TOP LEVEL, 1420 FT., DIVIDED INTO 23 BENCHES. TOTAL QUANTITY OF 39,700,000 CU. YD. OF OVERBURDEN AND 54,678,700 TONS OF ORE.

Do you care to say anything about your policy in regard to the litigation?

No, under the circumstances, I deem it best not to say anything.

What do you consider the most satisfactory episode in your career?

Of course, from both a professional and business standpoint, I have, and always will have, the greatest satisfaction as being the first, so far as I know, to recognize the possibilities of a character of low-grade ore in the Utah Copper Company's properties that had not before been commercialized, and which kind of ore today serves as the basis of more copper production than the total output of the United States at the time I began the development and equipment of the Utah. The United States was refining 900,000,000 pounds of copper per annum when the Utah Copper Company started, and the porphyry coppers, including those of South America, are producing more than that today. I naturally feel the greatest satisfaction in that; but it is only a greater satisfaction in point of precedence and degree; precedence because Utah was the first, and degree because it is the greatest. I have had just as keen a sense of satisfaction in successfully developing the other mines; the success of any one of them has been no more gratifying than that of any other, and my interest in each has been as great as it has been in any other.

A thing that has been about as gratifying to me as anything I have done is having been instrumental in getting together the Utah Power & Light Co. Water-power had not been developed when we started the Utah Copper operations—not to an extent justifying my using it. It wasn't sufficiently dependable, so we built steam-power plants. Later, I thought it should be developed, and called the attention of some of my friends and people in that business to the possibilities of power-development in Utah and Idaho. We purchased the Telluride company's properties, and along with that acquired some 30 other corporations engaged either in the production or distribution of power, and out of all we have built up the present Utah Power & Light Co., of which I am president. This company now supplies the Utah Copper Company with all its power and is one of the greatest institutions of its kind in the country.

Do you think it likely that any further large disseminated copper deposits will be found in the West?

I think in all probability there will be some, but I think the most important ones have been discovered and developed; the reason I think that is because all of those that have come into prominence and are big producers today have been known for generations; engineers and laymen have known they contained copper; there hasn't been a single one actually discovered in recent years. The Utah deposit has been known for fifty years; the soldiers of Johnson's army knew about it and prospected in it. The old Ruth mine, of Nevada, and some of the other deposits there, were worked a very long time ago. Ray has been known for over forty years, since 1874, when I believe the first records show somebody going in there and prospecting streaks of high-grade ore. Chino was worked practically by the ancients; there are records of Mexicans having taken copper out and packed it on the backs of 'jacks' to Mexico City in 1804. In the Miami district, the old Black Warrior and other claims were worked for their oxidized copper ore for a very long time; and the green outcrops of the district were

among the earliest known of copper showings in Arizona. The Braden mine was worked by the ancients. The Chuquicamata mine has a record of operations covering hundreds of years. All of the big things of this kind have been well known for their superficial showings of copper ore. People didn't recognize the importance of 'secondary' enrichment; that ore having a low value on the surface was a probable index of higher-grade ores lower down; they looked for veins. Furthermore, modern appliances and metallurgy, as well as cheap transportation and ready markets for large production were necessary to the success of this kind of enterprise.

What is the outlook for copper after the War?

I think there will come a time after the War—I don't predict how soon—when copper will again be very abundant for the world's needs, and that the price will again reach levels that we speak of as being below normal, having in mind the average price of copper for a decade before the War. I think, however, that the situation will quickly right itself; the price of copper must necessarily tend upward. The average price of the metal for the ten-year period preceding the time when we started opening the Utah mines was about 13½ cents; the average price for a period of ten years following that time was about 15½ cents. We have been running those mines now about 13 years; that would exclude the high prices of 1915 and 1916. I believe that another ten years will show an average price nearer 20 cents than 15 beginning with 1915. The price must necessarily go up, because if we consider all the reported developments of copper ore in the world that can be measured, all of the great 'porphyry' reserves, and only consume copper at the present rate, that is, the present normal rate—the rate prevailing immediately before the War—we haven't enough copper ore in sight in the world to maintain that production and supply that consumption for more than a short generation.

THAT MINE-TIMBERS of white spruce, Sitka spruce, white birch, and western hemlock grown in the Chugach National Forest, Alaska, are fully as good as Douglas fir from the Rocky Mountain region and superior to other Rocky Mountain species for use as mine timbers, has been demonstrated by the Forest Products Laboratory at Madison, Wisconsin. Tests to determine the suitability of the Alaskan trees for mine-timbers showed that in bending-strength developed, the four species named are from 20 to more than 100% stronger than lodgepole pine, alpine fir, Engelmann spruce, bristle-cone pine, and Western yellow pine from the Rocky Mountain region. These species are all widely used as mine timbers. Sitka spruce, white birch, and Western hemlock from Alaska proved considerably higher in average strength than Rocky Mountain Douglas fir. White spruce averaged nearly as well.

POTASH to the amount of 350,000 tons yearly is wasted in American cement and iron-furnace plants.

Colorimetric Methods for Copper Present in Small Quantities

By R. FRANKLIN HEATH

Recently I was called upon to make a complete analysis of electrolytic lead. As copper was present, I proceeded to determine it by the usual methods, first with KCN and then with KI, but found that the results would not check. I then resorted to the colorimetric methods, and have since been using them for the determination of copper when present in small quantities, as for instance, in non-cupric alloys and bullion, where the copper-content is below 0.05%, although by dilution accurate work can be secured on material containing as much as 1%. A colorimeter or a rack of colorimetric tubes is all that is necessary outside of the regular assay-laboratory equipment. It is necessary to adopt a standard reading-temperature, as color-reactions are somewhat modified by an increase or a decrease of temperature. The solutions must be clear, and the tubes bright and shining, before adding the reagents. It is desirable to maintain an evenly diffused light in which to observe and compare the colors. All the reagents should be of the highest quality. Weigh out 0.1 gm. of copper foil; dissolve in 5 cc. nitric acid; add a few drops of sulphuric acid, and evaporate to expel the nitrous fume; dilute to 1 litre with distilled water; 1 cc. of this solution contains 0.0001 gm. of copper. This constitutes the standard copper solution. To prepare the ammonium-nitrate solution dissolve 10 gm. of ammonium nitrate in 100 cc. of distilled water. This solution is added to the ferrocyanide solution to secure a sharper reaction, whereby the colors are more easily compared. The potassium-ferrocyanide solution is made by dissolving 20 gm. of the salt in 50 cc. of water and diluting to 500 cc.

Take 1 to 10 gm. of the sample, depending upon the quantity of copper probably present; treat with nitric acid; boil until decomposed; add 5 cc. sulphuric acid; boil; filter off the insoluble matter; wash with 25 cc. warm water; precipitate the copper from the filtrate with aluminum foil; collect the precipitated copper; dissolve in dilute nitric acid; boil to expel nitrous fume, and evaporate to 10 cc. in case copper is present only in small quantities, but if present in larger amounts dilute to exactly 100 cc. Have at least two Nessler or colorimetric cylinders at hand, (test tubes may be used); into one of these pour 5 cc. of the ferrocyanide solution; add 10 cc. of the solution of the sample to be determined; dilute to 100 cc. with water; and add 5 cc. ammonium-nitrate solution. In the other cylinder put 5 cc. of the potassium-ferrocyanide solution; dilute to 80 cc. with water; add 5 cc. of the ammonium-nitrate solution, and run in standard copper solution from a burette until the colors match. Note the number of cubic centimetres of standard solution required, from which the copper percentge may be calculated. By using a standard solution of KCN and ammonium hydroxide, copper may be determined in the same manner as above.

Industrial Mining Schools in Nevada

By FRANCIS CHURCH LINCOLN

There are four systems of educating miners in operation in the United States today: (1) admission of miners as special students to certain regular classes in mining colleges, (2) special short courses for miners at mining colleges, (3) correspondence courses in mining offered by mining colleges and by private corporations, and (4) courses given so as not to interfere with the regular work of the pupils at industrial mining schools. Systems of preliminary vocational training, such as mining courses in high schools and in mining trade-schools, have been omitted from this classification since their object is to train men to become miners rather than to train men already engaged in the occupation of mining. The special-student and short-course systems do not fully meet the requirements, since a miner rarely possesses the initiative, the spare time, and the necessary cash to take advantage of them. Correspondence lessons sometimes produce good results, but are not as effective as courses directly taught. Industrial mining-schools under good teachers appear to be the most satisfactory means of instructing workmen. The advantages are manifold; the instruction adds to the interest of the men in their work and increases their ability; it improves the safety conditions in the mines and adds to the moral tone of the mining communities. Time that might otherwise be wasted is profitably employed in study; a supply of trained men for positions of minor responsibility is ensured; and ambitious students are prepared to enter a mining college.

The Mackay School of Mines at the University of Nevada, in Reno, admits miners over twenty years of age to all regular classes which may be of benefit to them; a prospectors' short course of four weeks' duration is given at the Mackay School of Mines each spring, and many miners throughout the State are taking private correspondence school courses in mining subjects. Similar conditions exist in most of the metal-mining States, but Nevada is unique in maintaining four industrial mining schools in the mining centres of Virginia City, Tonopah, Goldfield, and Ely.

NIGHT CLASS AT WORK IN TONOPAH INDUSTRIAL MINING SCHOOL.

Industrial schools for coal miners were first developed in Europe, and were introduced into this country many years ago. The first of these was the Freeland Mining and Mechanical Institute, established in 1879 at Drifton, Pennsylvania, by an eminent mining engineer, Eckley B. Coxe. This school has been in successful operation ever since, and was the forerunner of numerous similar schools in other coal-mining States. The University of Nevada, however, appears to have been the pioneer in establishing metal-mining schools. It opened the Vir-

ginia City School of Mines as an extension department of the University at Virginia City, on the famous Comstock Lode, in 1900. In 1905, this department was raised to the rank of a school and was placed under the State Board of Education. In this form it exists at the present time. The second industrial mining school was opened at Tonopah in May, 1915, and as a result of its success, the legislature at its last session authorized the creation of additional schools at Goldfield and Ely. These three schools are governed by the Board of Regents of the University, the Director of the Mackay School of Mines being given supervision over them. The State Board of Education has done likewise with the Virginia City School of Mines, so that the control of all four schools is centred in the mining college of the State University. Dwight P. Smith has been the principal of the Virginia City School of Mines since its detachment from the University in 1905, and has developed a system of education that has proved most successful. The entrance requirements are ability to read and write English. The school is under student self-government. The funds supplied by the State having proved insufficient to meet the requirements, the students' association charges an admission fee of $5 and monthly dues of $2.50. The school is open 10 hours per day in order to accomodate men working on different shifts, and the pupils are expected to attend at least 2 hours daily. Instruction is individual. The subjects taught are as follows: (1) Mathematics through descriptive geometry and plane trigonometry, (2) physics, including mechanics, heat, and electricity, (3) surveying, (4) mechanical drawing, (5) mineralogy, chemical analysis, wet and fire assaying, (6) cyaniding, (7) prospecting, involving geology, identification of rocks, field observation, rudiments of mining law, and field testing for metals.

The attendance during the last biennial has not exceeded 12 students at any one time; this appears to be due to the fact that the school has been in the camp for a long time, and the camp employs but a small number of men. In one respect this is fortunate, since the satisfactory individual instruction of a large number of pupils by one teacher is impossible.

Ellsworth R. Bennett is principal of the Tonopah School of Mines, situated at the biggest silver camp in the Silver State. The educational system at Tonopah, while resembling that of the Virginia City school in some particulars is quite distinct. There is no student self-government, and class instruction is used in place of individual instruction whenever practicable. Classes are held both in the morning and in the evening for the convenience of men working on different shifts. The laboratory is open during the afternoon. No sessions are held on Saturday or Sunday.

The total enrollment of the school has been 94 students, and the present enrollment is 31. In addition to the subjects already given it is proposed to teach drawing, surveying, prospecting, mining, and the metallurgy of silver. G. E. Hofmann has been appointed principal of the Goldfield School of Mines and V. M. Henderson of the Ely School. Both are to be opened before June 1 of the present year. The instruction will probably be similar to that at Tonopah, with local variations to meet the special needs of the different camps. For example, at Goldfield the metallurgy of gold will take the place of silver, while at Ely the metallurgy of copper will be accentuated, since Ely is the most important copper camp in the State.

In addition to schools maintained at the more important mining centres, a movable school serving the smaller camps might accomplish good. A specially equipped car could be used as class-room and laboratory for small mining communities on the railroad, and such equipment as was necessary might be transported from it to towns at a distance. The traveling school would remain several months at each place, and its movement might be guided by advance registration at the camps desiring its service. It would also seem advisable to introduce into the United States a fifth method of educating the miner, namely to send teachers into the field to instruct men at the small mines which even the movable school would not reach. The instructor would undertake to do for the miners essentially what the agricultural extension teacher does for the farmers. The mining extension-teacher might be directed by the U. S. Bureau of Mines or by the State University, visiting mines and prospects in the order of the requests made, or going into the newer districts to impart such knowledge as would prove most beneficial. A similar system is in successful use in Canada and in other parts of the British Empire. In view of the educational assistance of this character so long extended to the farmers, it appears strange that the miners have been left without such aid.

Tungsten refining as now practised by the High Speed Steel Alloys, Ltd., a corporation organized in England under advice of one of the Government war-committees, consists in mixing the crushed screened concentrate with soda-ash; this is roasted in a coal-fired reverberatory furnace for about three hours; the roasted product is boiled in water to extract the soluble sodium tungstate that had been formed by roasting; the solution is filtered off, and hydrochloric acid is added to the filtrate to precipitate tungstic oxide. This is filtered and the tungstic oxide dried, after which it is mixed with powdered anthracite coal and charged into crucibles that are heated in coke-fired furnaces. The reduced metal is washed in pans and gently dried, the final product being a chocolate-colored powder assaying 98 to 99% tungsten.

The Navy Department has issued an appeal that suggestions for improvement of storage-batteries be submitted to Lawrence Addicks of the Naval Consulting Board, 126 Liberty street, New York. Modification of the lead storage-battery or its electrolyte, tending to develop greater power for a given weight or size, as well as designs for new types of storage-batteries, more reliable and efficient than those now in use, are earnestly desired.

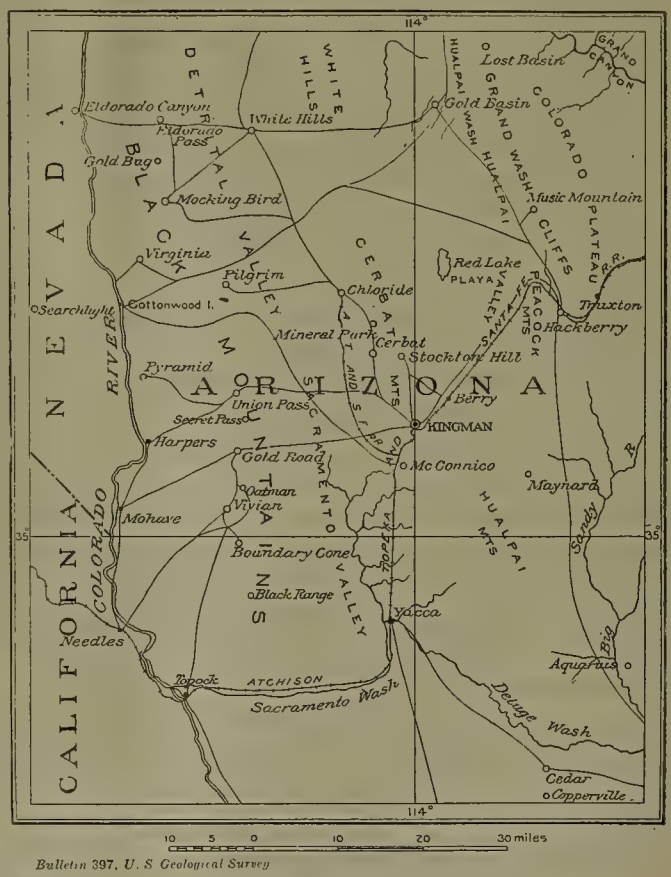
Mining in North-Western Arizona

By R. T. MASON

For about a year, or since the Oatman excitement began to subside, mining activity has increased in the Cerbat mountains, a district north and east of Kingman, Mohave county, Arizona. There was no United Eastern nor United Verde Extension to start a stampede to Chloride; but if there has been less excitement to mesmerize the inexperienced and the ill-advised investor, fewer failures may be expected than usually follow a mining boom. One of the productive mines in this region, the Golconda, is about 15 to 18 miles from Kingman, on the steep western slope of the range, where, looking across the Sacramento valley from the shaft, Union Pass, Secret Pass, and the peaks east of Oatman are clearly visible. The Golconda is a zinc mine operated by the Union Basin Mining Co. The stock is owned by N. L. Amster, of Boston, the majority shareholder, and by the American Metal Co. The manager is J. D. Wanvig. The ore in the main Golconda vein is confined to a high-grade streak averaging 18 in. thick, but varying from a few inches to 6 ft. or more, in lenticular shapes. On both the foot and the hanging wall is soft waste that mixes with the ore mined, thus making a milling ore averaging about 16% zinc. This metal is present as black jack with iron in the combined form, therefore not susceptible to mechanical separation one from the other.

About 150 tons per day is stoped from the 1000 and 1100-ft. levels and hoisted through the main shaft, which is an incline on the Golconda vein. At present the development is confined to the 900, 1000, 1100, and 1200-ft. levels. Sinking will be resumed when the station is completed on the 1200-ft. Ventilation is afforded by the natural passage of fresh air through the Prosperity adit, which is north of the main shaft at the 600-ft. level, thence, through the lower workings, and out through the Tub shaft near the south end of the mine.

The concentrator, situated immediately below the shaft, at present consists of two parts, a crushing and a coarse-concentrating plant, being the old Golconda mill with jigs and tables; and a fine concentrating plant which treats the tailing from the old mill together with enough from a tailing dump, containing 5½% zinc, to make a feed of 200 tons per day for the tube-mills that operate in closed circuit with Dorr classifiers, thence delivering the pulp to Callow flotation cells. Plans are under way, but not yet consummated, for making changes throughout the concentrator. The machines best adapted for the treatment of the ore are being determined by experiment. It has, however, already been decided to replace the tube-mills with Marcy mills. Water is carefully conserved. From 1200 to 1500 tons of concentrate is produced each month, containing about 42% zinc, 9% iron, 1% lead, with some silver and gold. The total extraction is 87%. The concentrate is delivered by automobile truck to the railroad about five miles distant. During 1916 the production was 11,000,000 lb. zinc, 80,000 oz. silver, and 5000 oz. gold.



Bulletin 397, U. S. Geological Survey

PART OF NORTH-WESTERN ARIZONA

From Golconda to the old camp of Mineral Park is about 5 miles across the hills to the north. Here the Keystone Consolidated Mining Co., controlled by G. S. Holmes and associates of Salt Lake City, Utah, is doing development work. Recently, F. W. Sherman, who was for many years at the Daly West mine, Park City, Utah, has taken charge. The management is pursuing a conservative and business-like policy, and has excellent pros-

pects for developing a paying mine. Driving has been done on the 150 and 300-ft. levels. Between the two the oxides change to sulphides containing iron with small percentages of copper, zinc, and lead, carrying silver. The most valuable constituent of the ore occurs as pyrargyrite, Ag_3SbS_3, ruby silver, and probably proustite, Ag_3AsS_3. The gangue is quartz. The vein and walls both being hard, the latter stand well, requiring little timber. A mill, in which the Fields flotation process has been installed, has been built under contract for the company. The ore would seem to be especially adapted to flotation treatment.

Not far from the Keystone the Washington and Arizona Copper Co., controlled by Elmer D. Reese, is developing its property through three adits, the lowest one, about 600 ft. long, is driven on a vein of sulphide ore valuable for its silver-content. A winze being sunk below this level is now over 30 ft. deep and said to be in ore. A second vein has also been explored in one of the upper adits and contains copper in marketable quantity. It is the expressed intention of the owners to pursue the wise policy of blocking out sufficient ore to warrant the erection of a mill before beginning its construction. The Golden Hammer, lying between the Keystone and the Washington, is being worked under lease and bond. It has ore all the way in a 400-ft. adit, and appears to be a promising prospect. About a mile from Mineral Park, near the automobile road to Chloride, on the flat just beyond the mountains, a small disseminated copper deposit, unique in character, is being worked by Kingman capitalists. A surface conglomerate-bed, stained green throughout with copper carbonate, and said to contain some sulphide and silicate, has been sufficiently prospected with test pits to justify the owners in estimating an area of 600 by 200 by 20 ft. deep, or approximately 200,000 tons, averaging 2.85% copper. The conglomerate pebbles have been identified with rocks of the mountains near Mineral Park. In laboratory leaching-tests, crushing to one-half inch, and using 10% sulphuric acid solution, a 90 to 93% saving was effected in 3 days, or 72 hr. It was found by employing air agitation that the same extraction was obtained in about half the time. A leaching plant of 100 tons daily capacity is now being erected. The ore will be excavated in an open pit and handled first by car and later by drag-line scraper, leached with a 7% sulphuric-acid solution in wooden tanks with air agitation for about 36 hr. About 80% of the copper will be deposited electrolytically with current derived from the Kingman power-plant, and the remainder, about 20% of each charge, will be drawn off and the copper deposited on scrap iron. It is thought that this proportion of fresh solution each time will prevent fouling. After the solution is drawn off each charge will be washed for about 2 hr. The electrolytic method of recovering the copper will not only save much of the acid but the water also, an important item in that vicinity. The operators are the Emerald Isle Copper Co., a corporation controlled by J. W. Cornelius, R. C. Jacobson, J. C. Stricker, and J. H. Conway, all of Kingman.

The town of Chloride, about eight miles north of Mineral Park, is the terminus of a spur leaving the main line of the Atchison, Topeka & Santa Fe railroad at McConnico, about 4 miles south of Kingman, and running up the east side of the Sacramento valley, serving all the camps on the west side of the range. The distance from Kingman to Chloride is about 29 miles. The Needles Mining & Smelting Co., a subsidiary of the U. S. Smelting, Refining & Mining Co., owns the Tennessee mine at Chloride and other mining property in the Cerbat range, and also the concentrator and smelter at Needles, California. The smelter has not been operated since it was acquired by the United States company. D. R. Muir is manager of the Needles company and the Gold Road mine in the Black range, and N. J. Churchill is superintendent of the Tennessee mine, the principal producer in the immediate vicinity of Chloride. The mine is operated through a vertical shaft to the 1400-ft. level, and a winze from the 1400 to the 1600-ft. level where driving is now in progress. About 150 tons of ore containing 15 to 16% zinc, 6 to 8% lead, 28% iron, and $7 in gold and silver, is hoisted daily from the stopes above the 1400-ft. level. The vein dips easterly from 78 to 80°, except between the 900 and 1200-ft. levels, where it turns over to 75° westerly. The ore lies between a granite-schist foot and a pegmatite hanging wall, and is always associated with the latter rock. It assumes lenticular forms, usually one orebody being directly above another and sometimes separated by only a few feet of gouge. The ground is heavy and costly to timber. Square sets are employed, the stopes being filled as the work progresses, and spiling is frequently needed. The cost for timbering is 78c. per ton. Wages for underground work range from $4 to $6; contracts are let on development work; and the bonus-system is used in all cases.

The ore is shipped by way of the Santa Fe railroad to the concentrator at Needles. The zinc in the Tennessee ore occurs both as black-jack and as the resinous variety. On account of its habit of excessive sliming the tailing formerly contained 8% zinc, but this has since been reduced to 2.5% by the introduction of flotation. The tailing now contains about 0.1 oz. gold, 0.6 oz. silver, 0.1% lead, 2.5% zinc, 5.7% iron, and 77% silica.

The Schuykill adjoins the Tennessee on the north and, like many others in the district, it is an old mine reopened. The 700-ft. level has been reached, and it is reported that sinking will be continued to the 1000-ft. level. A few cars of ore have been shipped. The Elkhart lying farther north of the Schuykill is another old mine of the district, re-opened and in process of development. The Stockton Hill section, lying on the east side of the Cerbat range, and about east of the old town of Cerbat, is sharing in the general activity. Two of the best known properties are the Wrigley group, and the Arizona-Butte, which is now operating a mill. Most of the ore in the entire Cerbat district requires concentration to be marketable and water for the purpose is scarce, but the mills in operation seem to have sufficient by using water-saving appliances.

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

MILL FOREMEN should frequently go over the main-line and counter-shafting in the mill to see that it is in line. Timbers shrink and warp with time, and the boxes carrying the shafting move with these changes of position in the timbers, greatly increasing friction and even resulting in the breaking of a shaft.

COMPRESSED-AIR requirements for flotation in the Callow cell, used in many concentration-mills, are 130 cu. ft. of free air per minute at 5 lb. pressure, the treatment-capacity of a cell averaging about 50 tons of solid in the pulp per 24 hr. Expressing it otherwise, there is needed 2.6 cu. ft. of free air per minute at 5 lb. pressure per 24-hr. ton.

SCHEELITE when found in pegmatite veins is frequently associated with fluorite, molybdenite, and wolframite. In such cases it is not uncommon for some of the tungsten in the scheelite to be replaced by molybdenum. As these two substances are difficult to separate in the practical operation of refining the scheelite is reduced in value accordingly.

MARMATITE is a variety of zinc blende containing large amounts of iron, sometimes exceeding 10%. The iron is present as the mono-sulphide (FeS). The mineral is often highly lustrous, with a metallic reflection, and its color ranges from deep black to brown. When pulverized the powder is magnetic, dependent upon the amount of the ferrous iron that is present.

WATER AND HEAVY AIR-PIPES in mines, particularly in shafts, should be connected at every other joint, by flanges instead of the usual couplings. The flanges give a good substantial bearing for yokes or other means of support to the pipe, and they also permit repairs or changes to be made without disconnecting long lengths of pipe, or of resorting to cutting the pipe.

IN our issue of April 14 it was stated on this page that a long pipe would empty a reservoir more quickly than a short pipe. This was wrong. The formula is:

$$h = f \frac{lv^2}{d2g}$$

The loss of head in friction is directly proportional to the length of pipe; if you double the head you double the friction.

MULTIPLE-ARCH dams of medium height cost less to construct than rock-fill dams, especially if the latter are provided with anything better than a wooden up-stream face as a water-tight cut-off. The stresses and dimensions in a multiple-arch dam can be accurately calculated, so that the factor of safety is ascertainable within narrow limits. In case of floods, when water may overflow the crest, a dam of this design will not be injured. Details concerning the design and construction of this relatively new type of dam are given by L. R. Jorgensen in the Proceedings of the American Society of Civil Engineers for March, 1917.

ONE CAUSE of the large amount of water coming from the cylinders of hoisting-engines is that ordinarily hoisting-engines are employed intermittently. During the periods of idleness steam condenses in the piping connecting the boiler and engine-cylinder. This condensation can be minimized by covering the steam-pipe with a thick non-conducting material such as magnesia or asbestos-packing.

GRAPHITE occurs in both igneous and sedimentary rocks. The origin of the veins is not well understood. Some geologists believe that they may have been derived from the gaseous constituents of the magma. Below 500° C. a reaction will occur between carbon monoxide and hydrogen, forming carbon and water-vapor. It is thought that the deposits in Ceylon, and at Ticonderoga, New York, were formed in this way.

SCALE IN BOILERS is composed mainly of carbonate of calcium and magnesium, and the sulphates of these metals. Less frequently are found iron carbonate, magnesium chloride, calcium chloride, potassium chloride, and sodium chloride. Mud also causes scale, but this can be prevented by filtering the boiler-water. Never use an acid water in a boiler. The acid must be neutralized by adding an alkali to the water before it enters the boiler. Carbonate of soda is a good neutralizing agent, if not used in excess.

STAMP-GUIDE TIMBERS of a stamp-mill require close attention. The jar from the stamps causes the stems to wear the wood, until the guides become loose. Often the guide-timbers are in two sections, and wedges are placed between. As the guides wear, the wedges are reduced in thickness from time to time, permitting the guides to come closer to the stems, keeping them at a proper distance. When the guides wear so as to allow too much movement to the stem, the shoe is likely to strike the die a glancing blow, and may cause the breaking of a stem.

RUST can be cleaned from corroded iron and steel plate and machinery by applying to the surface so affected a moistened mixture of two parts of pulverized sodium bi-sulphate and one part of common salt. The operation may be hastened by scraping off the mixture every two or three hours, brushing the surface with a wire brush, and then re-coating with the anti-corrosive material. The plate should be clean within 24 hours. Wash well with a solution of soda-ash, dry quickly, and then coat with paraffine oil to protect the surface from oxidation. This method is more effective than hammering, chiselling, or cleaning with a sand-blast.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

PACKARD, NEVADA

CONSTRUCTION OF MILLS UNDER WAY AND NEW PLANTS BEING PLANNED.—RAPID DEVELOPMENT.—PROSPECT OF MINING LITIGATION.

With the melting of the snow increased activity is noticeable in the Packard district. A stage-line is now in operation between Rochester and Packard, making four trips daily, and a post-office will soon be granted to the town. Delay in its establishment was due to the refusal of the postal department at Washington to accept the name of Packard for the camp, due to its duplication in other States.

Grading for the 300-ton mill of the Rochester Combined Mines Co. will be commenced before May 1. The contract for its design and erection was given to K. Freitag, who designed and built the Packard mill, a half mile from the site of the new mill. In general the flow-sheet will follow that of the Packard. Crushing will be done by a 7½ Telsmith crusher. Rolls are to be eliminated, the 2-in. product from the crusher going to 6 by 5-ft. ball-mills using 5-in. balls; re-grinding in 7 by 10-ft. pebble-mills in closed circuit with Dorr classifiers. Dorr agitators and tray-thickeners will be used, followed by Oliver filters, precipitation to be by Merrill presses. Electric power will be used, the power-lines having already been brought in. The mill will be built in two units of 150 tons each, to be completed and in operation by November 1. Provision will be made for the addition of a flotation-unit to treat tailing if increasing quantities of sulphide in the ore should justify it. The value in the ore so far opened consists almost entirely of hornsilver.

The flow-sheets of the two mills now operating in this district differ radically. The Rochester mill uses heavy stamps, with straight counter-current decantation and zinc-thread precipitation, whereas the Packard uses modified counter-current decantation, followed by filtration and zinc-dust precipitation. The same management controls both the Rochester Mines and Combined Mines, so that their decision to eliminate stamps and add precipitation-presses and filters is interesting.

The big contact orebody on the Shepherd claim of the Combined Mines is being rapidly developed. The upper adit has followed the vein to within a few feet of the Packard end-line. The main working-adit recently cut the orebody over 200 ft. below. The contact has been opened up at several points between there and Rochester and some low-grade ore developed. Ore will be delivered to the mill from the outlying claims by electric-haulage. Over 50 men are now employed. The development and equipment of this property has been spectacular, to say the least. Within a few weeks in December the 80 claims were purchased and surveyed. At that time assessment work constituted practically the only development. A compressor driven by a Diesel engine was installed in January and work was begun on the various parts of the property. Nine months after the first man was put to work, the company expects to be treating 300 tons of ore daily in its own mill.

The increase in the capacity of the Packard mill from 100 to 150 tons daily will probably be secured by the addition of tray-thickeners and by some changes in the grinding-units. Development work on the property during the last few months has fully justified the increase. The 120 tunnel has been driven for over 900 ft. along the contact orebody. It will be rapidly advanced to cover the remaining 400 ft. to the end-line, where it will connect with the lower tunnel of the Combined Mines. Work is being started on a series of raises to make available for milling large bodies of surface ore opened up by lessees in the early days of the camp. Prospecting of the belt of silicified rhyolite lying east of the 'dike' outcrop will be begun soon.

The discovery of rich ore on the 800-ft. level of the Rochester mine is encouraging. This represents deep mining for this district. The Rochester Mines company probably will have its new aerial tramway in operation before May 1. The mill is running steadily at full capacity.

The Nenzel-Crown Point property is preparing for the erection of a 150-ton cyanide-plant. Designs for this mill also are being drawn by K. Freitag. It is probable that a combination of flotation and cyanidation will be used. Unlike the other ores in the district much of the ore from the Crown Point is sulphide, containing a higher proportion of gold than the average of the district.

There are persistent rumors to the effect that the Merger will begin an apex-suit in the near future against the Rochester Mines Company. With the complex systems of faulting in this district such a suit holds interesting possibilities.

OATMAN, ARIZONA

STOPES STARTED IN THE UNITED EASTERN.—NEW ELECTRIC MACHINERY INSTALLED.—MILL OPERATION SATISFACTORY.

During the month of March the United Eastern Co. milled 6584 tons of ore, of an average value of $23.84 per ton, and a total gross value of $156,962.59. The mill made a recovery of 96.15% of the value.

Stoping is under way on the 465 and 565-ft. levels, where widths up to 40 ft. are being mined. Two benches of square-sets are being erected on each level, but above these the stopes will be worked by a variation of the cut-and-fill system. On the 665-ft. level the cross-cut from the main shaft has made connection with the drift from the old shaft, and the bottom of the drift is being cut to adjust the grade.

Preparations for resuming sinking at the main-shaft are under way. A single-drum electric hoist, 37½ hp., has been erected at the 665-ft. station. A heavy bulkhead has been built under the main hoisting-compartments and the sinking will be done through the third compartment. It is planned to sink an additional 300 ft., after which the first cross-cut will be driven to the vein at the 965-ft. level. Below the 665-ft. level the drifts will be run at vertical intervals of 150 ft. No exploration work is being done. The large amount of work on the sill-floors while cutting out the stopes makes development work impracticable at this time. However, during the preliminary stope-work, branches of the vein have been opened in the walls of the 465 and 565-ft. levels, which have increased the quantity of ore blocked out considerably above that estimated during the period before stoping began.

The mill has been operating satisfactorily. A few minor changes have been found necessary since milling was started, principally for the purpose of securing finer grinding than was at first possible, and 90% of the ore is now being ground fine enough to pass through a 200-mesh screen. The average daily tonnage for March was 212.5 tons. The future supply of cyanide for milling operations has been taken care of, and

from this time forward there appears to be no likelihood of a shortage.

A decided improvement is reported in the Gold Ore mine, at Gold Road. At 50 ft. depth in the winze, at 580 ft. from the surface, the vein is 6 ft. wide and recently has averaged over $300 per ton. There is a streak of white quartz liberally sprinkled with gold. Last summer the company milled 2000 tons of ore at the Gold Road mill that averaged $14.50 per ton. The plan is to build a mill this year.——Development in the Gold Road Bonanza has brought the working close to the main vein in following a spur vein on the 550-ft. level. On the 250-ft. level the main vein is 60 ft. wide and is said to average $3.10. It is expected that the value of the ore will be higher at 550 ft.——A stockholders meeting of the Big Jim Gold Mining Co. was held at Phoenix, Arizona, April 24, to ratify the action of the directors, on April 4, in selling the Big Jim and Monarch claims, comprising the Big Jim mine, to the United Eastern Mining Co. On May 1 the mine will be turned over to the United Eastern, and A. G. Keating, the superintendent, will take charge of the Big Jim Consolidated, successor to the Big Jim Gold Mining Co., and start the development of the Bluebird property. Three shifts will be employed and the shaft will be sunk from 240 ft. to a depth of 600 ft., where the vein will be explored. The annual meeting of the Tom Reed Gold Mines Co. will be held on April 30, at Kingman, Arizona, for the election of directors and the discussion of the affairs of the company. The reconstructed 300-ton cyanide-mill will be in operation about May 1. The new board of directors will visit Oatman and inspect the underground workings.

AUSTIN, TEXAS

Texas Has Many Deposits of Valuable and Useful Minerals. Sulphur and Quicksilver Are Important.

William B. Phillips, former director of the Bureau of Geology and Technology, of the University of Texas, has just finished making a preliminary survey of the mineral resources of the State. He says that Texas can supply graphite, molybdenite, petroleum and its products, quicksilver, copper, iron, silver, and sulphur in almost unlimited quantities for the nation's needs. The production of graphite of the flake variety has not yet assumed large proportions, but there are two mills in the State now equipped for the making of what is known as '55' graphite, flake graphite containing from 50 to 55% graphite, which is much used in foundries and machine-shops. These are the mills of the Texas Graphite Co., nine miles West of Burnet, and the Dixie Graphite Co., five miles north-east of Llano. These mills can now grind and concentrate about 25 tons each per day of the crude material. The yield of graphite from this material is from 8 to 10%. With the expenditure of a few thousand dollars these mills could produce a much better grade of graphite than they do now. On the property of the Dixie Graphite Co. there has been uncovered a vein of molybdenite. On Honey creek, in Llano county, molybdenite occurs with native bismuth and some prospecting has been done there of late. Molybdenite also occurs in the Quitman mountains.

The petroleum production during the two years ending with 1916 was 40,000,000 barrels. There are now in the State nineteen oil-refineries with a total combined daily still-capacity of 218,000 barrels. There are three other refineries not now in operation, but within a short time the daily capacity of all the refineries in the State will be about 140,000 barrels. Of the refineries in operation five are situated on tidewater, or on canals connected with tidewater, at Beaumont, Port Arthur, Port Neches, and Texas City. These five refineries have a daily capacity of 130,000 barrels. The principal refineries in the State are connected by pipe-line with the wells in Texas and in the Oklahoma fields. The guarding of the refineries and pipe-lines will have to be undertaken, possibly by State troops. Texas is now, and has been for several years, the second largest producer of quicksilver in the country. The mines and furnaces are in the southern part of Brewster county, not more than two hours' ride from the border. The total value of the quicksilver produced in the State is now close to $3,000,000. The ores are much richer than the average Californian ores, although California produces a great deal more quicksilver than Texas does.

There is but one producing silver mine in the State, that at Shafter, in Presidio county, but it has been in successful operation for 30 years. The total value of the product is close to $8,000,000. This mine is within 20 miles of the border.

The situation with respect to sulphur is particularly interesting. At Freeport, at the mouth of the Brazos river, there is a large deposit of sulphur worked by the Freeport Sulphur Co. The sulphur-bearing beds lie from 1000 to 1200 ft. below the surface and are worked by forcing super-heated water and steam down through pipes. This melts the sulphur and by pumping it back, the sulphur runs out of the pipe as liquid sulphur and is carried to open-air bins and allowed to cool. There are large piles of pure sulphur from which the railroad cars and vessels are loaded.

The plant here is extensive and represents a large investment. In Culberson county, south of New Mexico, there are deposits of native sulphur associated with gypsum and disintegrated limestone. In the aggregate there is a great deal of sulphur in this district, but systematic development is lacking. On one of the sulphur properties in Culberson county, in Maverick Springs district, 20 miles west of the Santa Fe lines at Orla, Reeves county, some development work has been done by the Michigan Sulphur & Oil Co. and from 200 to 300 tons of excellent sulphur has been produced. The sulphur is extracted from the ore by means of super-heated water and steam. The mine-cars are run into a large steel cylinder, this is then tightly closed and steam under a pressure of 40 to 50 lb. is admitted, the sulphur is melted, and is then tapped from the bottom of the cylinder, when the operation is repeated. The present production is small, the capacity of the plant not exceeding 10 to 15 tons of sulphur per day, even when the best ores are used.

Texas produces so little copper, lead, zinc, and gold that these items are not of much consequence. No pig-iron at all is produced, though there are excellent resources in these metals, with the exception of gold, but they are at present not utilized. There are tin ores in the Franklin mountains, near El Paso, but nothing has been done there for some years. In the Quitman mountains, 80 miles south of El Paso, there are some deposits of wulfenite (molybdate of lead), as also of tungsten ores, but they have been utilized to a very small extent.

SUTTER CREEK, CALIFORNIA

A New Industrial Enterprise Preparing for Business.—A Novel Method of Transportation Proposed.

The California Clay Corporation is having plans prepared for the plant to be erected at Ione for the manufacture of fire-brick and other products, and grading for the new buildings will begin shortly. Manager A. S. Cunningham is in the East, arranging for the shipment of the necessary machinery and equipment. The proposed plant is to have a capacity of 3,000,000 bricks annually and will cost approximately $65,000. This company has secured a 50-year lease on 30,000 acres in the Arroyo Seco grant, which contains one of the largest clay deposits west of the Mississippi. Local capital is interested in the enterprise and the following men have been chosen as officers for the first year: Geo. C. Hallerton, president; A. S. Cunningham, vice-president and general manager; James R. Keith, secretary; and E. V. McGinto, treasurer.

Another important industry in course of development at Ione is the mining and refining of glass-sand and kaolin

suitable for the manufacture of chinaware and poreclain, this work being carried on by the Theo. Dittell company. Theo. Dittell is president and local manager, and W. D. Amick and other local men are interested in the project. The sand, clay, and kaolin will be mined on the ranch formerly owned by N. Clark & Sons, where 14 men have been put to work at stripping, and developing the deposits for shipment, and shipping will commence about May 1. Plans have been made for the construction of a plant at Carbondale, near Ione. The material when mined will be piped from the pits to this point, a distance of about 1½ miles. Operations at the mine are being rushed in order to begin the shipment of white sand to San Francisco, where a firm has contracted for the delivery of 10,000 tons per year for the next five years. This sand is regarded by manufacturers as of the highest grade and not below the finest quality of English sand. It is to be used in the manufacture of white bottles. The new company is said to have abundant financial resources.

The Drytown Consolidated Gold Mining Co., organized to take over the Crown Point quartz mine, near Drytown, has filed its articles of incorporation with the county clerk of Amador county. The capital stock of $50,000 is divided into 500,000 shares of a par value of 10c. per share, and each of the following trustees has subscribed for ten shares: R. R. Moore, Oatman, Arizona; G. C. Dickerman and Chas. R. Lombardo, Drytown, California, and J. W. Caldwell, Sacramento. This property was formerly owned by Mrs. M. E. Fontenrose of Jackson.

Cleaning out the bottom of the shaft and renewing timbers where necessary in the drifts and cross-cuts is still in progress at the Old Eureka mine at Sutter Creek. The new hoisting-machinery and equipment have not yet been put into use, although everything is about ready for operation.

HOUGHTON, MICHIGAN

COPPER STOCKS AND WAR PRICES AS THEY AFFECT SHAREHOLDERS IN THE LAKE REGION.

Lake Superior shareholders of copper are expecting a radical reduction in the price of copper, probably down to 20 cents for deliveries during the last six months of 1917. The prices now are the highest they have been since the Civil War, and the mines of the Lake Superior district are sold ahead until August, and some beyond that date, at prices averaging better than 28 cents a pound, the highest figure reached, for a great amount on future delivery, since the European war started. But the contracts with the allied governments for delivery during the last quarter of 1917 have not yet been made. The concession to the Government of 16 cents, made by the producers, was applauded by shareholders more enthusiastically when they saw that it meant only about three per cent of the copper output, but the average Lake Superior shareholder in copper stocks now has convinced himself that, if the producers made these concessions for the benefit of the United States government, some radical concessions must now be made to the Allies of the Government of the United States, because the success of the Allies is quite as much a matter of necessity to this country as to England. They assume, then, if 16-cent copper is given to the United States Government, a substantial reduction from 28 cents must be made to the Allies. It does not follow, however, that a similar reduction will be made to domestic consumers, but it is difficult to see how such a thing can be avoided, in the opinion of those usually well informed. The Lake Superior shareholders look upon this as a result of the participation of the United States in the world's war and are reconciled to make the contribution from their dividends, which have been unusually high since the War began. As far as the stock-market value of shares is concerned, a realization of this fact is not looked upon as a bearish argument, for none of the Lake Superior stocks have shown an advance in proportion to the earnings, and practically all are now selling on a 15-cent metal basis.

The Calumet & Hecla company now operates six shafts on the old Osceola lode. Four are down below 3000 ft. and two close to 2000 ft. deep. One-third of the product comes from foot-wall stopes. Advance openings give assurances for three years' work ahead on a grade of rock equal to that now coming out. In fact, the lower openings are showing a slight improvement in quality. The lode is irregular and sometimes runs as wide as 140 ft. with copper carrying at both the foot and hanging. Driving in the Osceola-lode shafts will exceed 18,000 ft. this year, at the present rate of advancement, compared with the high record of 16,000 ft. last year.

There is little hope of a material advantage from Lake shipping-rates for copper this spring, as navigation will be at least two weeks late in opening. As a matter of fact practically no copper is on hand at the smelters here, a condition decidedly unusual. The local copper mines expected to take care of their coal-shortage by early shipments, but coal has been coming in by rail for several weeks.

PORCUPINE, ONTARIO

PORCUPINE DISTRICT.—LABOR SITUATION ACUTE.—COBALT DISTRICT.—MINERS DEMAND HIGHER WAGES.

The Porcupine district is facing its first real crisis in its history. The labor situation daily is growing more acute. Not only is labor scarce, but it is most inefficient. Day by day the inefficiency of the mine-workers becomes more evident. Costs at every mine are now on an upward trend. This is due largely to the indifference and the inefficiency of labor, and in a lesser degree to the increasing cost of mining supplies. About 50% of the mine-workers are first-class workmen, but the remaining half are not more than 50% efficient, thereby undermining the effectiveness of the entire working-force. At present there would appear to be no remedy other than to curtail operations until the end of the War. A few weeks ago the curtailment of operations at the gold mines would have brought forth a torrent of criticism, in that at that time every ounce of gold was urgently needed to maintain war-credit in other countries, especially in the United States. The situation has now changed to such an extent that gold mining is of secondary importance. The change is due to the entry of our big southern neighbor into the conflict. By opening her immense resources to the credit of the Allies she has made it possible for every allied country in the world to curtail the mining of precious metal without seriously placing their credit in jeopardy. Whether or not such a development takes place universally remains to be seen, but such would appear to be the probability at least for Porcupine. Just now the mine-workers of not only Porcupine but also of Cobalt and Kirkland Lake are on the verge of asking for an increase of 50 cents per day. This will probably come in the form of a demand, and the burden, already heavy, would thus be increased something like one million dollars annually. The mine-managers have stated that the increase will not be granted. The mine-workers have intimated that the demand will be made. The situation has thus reached a crisis, the issue of which will probably be decided on May 7, at which time the mine-workers will hold their annual convention at Cobalt.

From a well informed source come rumors that the Government will take action to prevent the closing-down of the precious-metal mines of Ontario; that the Militia Act will be enforced, and that the mine-workers may then withdraw their demand. Unfortunately for the districts affected, mining men do not share such views, but believe that the Government would take advantage of the situation by recruiting men for the army, diverting others to agriculture, and to the work of manufacturing munitions.

At Cobalt, as at Porcupine, mining operations are being con-

ducted under the shadow of an impending strike. With the price of bar-silver above 70c. per ounce, however, the operators are doing everything in their power to forestall the miners in their threat of a demand for increased pay. To grant the increase would be a recognition of the union. As yet, the W. F. M. is not recognized in this part of the Dominion. The managers accordingly are paying a bonus of 50c. per day when silver is above 70c., and offer to pay 75c. when silver is above 80c. The plan has not met with favor among the workers, in that it does not better the position of those in the gold districts; moreover, whether the price of silver is high or low they must be assured a living-wage. This issue also will probably be decided at the annual convention in May.

The shipping of bullion from the Nipissing high-grade mill has been resumed after a few days, the stop being due to a shortage of oil. Last week Nipissing and the Mining Corporation of Canada shipped an aggregate of nearly $200,000 in bullion. In addition to this, nine cars of ore was shipped during the week.

The Mining Corporation recently shipped one car of ore from which 241,000 oz. silver was recovered, valued at $177,000. This is the most valuable car that has ever left Cobalt. Formerly the Temiskaming held the record, having about a year ago sent out a car containing 250,000 oz. The lower price of silver at that time, however, made the car worth approximately $150,000. At present prices the car would be worth $180,000.

Mining operations on the 1600-ft. level of the Beaver Consolidated is meeting with satisfactory results. Now, that these lower contact workings have been connected with the Temiskaming, development is being pushed. Remarkably rich ore is being mined from the winze at that depth, and the condition of the mine is generally greatly improved.

In the Kirkland Lake gold area the main shaft of the Kirkland Lake mine has reached the 600-ft. level, where a cross-cut is being driven for the purpose of cutting the main vein, which on the upper levels contained high-grade milling ore. This cross-cut should reach the vein within the next few days. The result of the operation will have an important bearing on the future of the camp, as this is the deepest work thus far in the district. Hitherto, the Tough-Oakes mine held the record for depth, having conducted considerable development on the 500-ft. level. During 1916 the Tough-Oakes produced $707,000. Now that the 65-mile electric-transmission line is completed, this mine is expected to produce about $1,000,000 during the current year. In the litigation between C. A. Foster, president of the company, and some of the English interests, the former has lost the first round; judgment, as handed down by Mr. Justice Kelly of Toronto, going entirely against Foster. An appeal is now to be taken, a stay of judgment having been extended meanwhile.

There has been an increase of activity in the Kirkland Lake district since the electric-power was turned on. Operations have begun on the Sylvanite claim, where several promising veins are showing on the surfacee. A shaft is being sunk to 100 feet.

BONNE TERRE, MISSOURI

Unusual Activity and Advancing Wages.—Old Plants Remodeled and New Ones Being Built.

The advancing price of lead has resulted in great activity in this district. The past year witnessed the largest output of lead in its history, and labor is now receiving the highest wages ever paid here. During 1916 the workmen received a 30% bonus on their regular wages. On February 1 this was increased to 40%, and on March 1 it was further increased to 50% and the second check, or bonus discontinued.

A serious coal-shortage occurred in the latter part of December, and the Federal Lead Co. was forced to shut-down for several days. Relief in the severe cold weather occurred and allowed the delayed shipments to reach the mines in time to prevent further shut-downs. The new mill of the Federal Lead Co. began operation early in January. This is the first new plant to be built in the district in several years. It is constructed entirely of concrete and steel and has been built in record time, being ready for operation eight months after construction started. Its capacity will be about 2500 tons. The new power-plant of the Doe Run Lead Co. is about completed and will start operating this month. This is a turbine-plant of 6000-hp. capacity, with the building constructed of brick, and modern in every respect.

A large amount of construction work is being done in all the mills of the district. New machinery is being tested with a view to securing a general improvement in operation. Ball-mills are being installed and tested for still higher recoveries.

The companies are all making arrangements for impounding the slime in settling-ponds instead of allowing it to run into Big river. Some of the ponds are completed and in use. At the Bonne Terre plant of the St. Joseph Lead Co., a large dam for the settling-pond has been built of 'chatt' from the mill. All the companies formerly allowed the slime to run into Big river, but the farmers in the district brought suit and recently won a court decision that compels the companies to stop this practice.

In the Fredericktown district the Catherine property and the old Mine La Motte, or Missouri Metals Co., as it is now called, are operating at full capacity. The Missouri Metals Co. is remodeling its mill, and the old North American Co. is practically re-building the entire plant of mines, mill, furnace, and refineries, and will shortly be operating, producing lead, copper, zinc, nickel, and cobalt.

NEVADA

New Developments at Goldfield, Manhattan, Nipton, and at Sweetwater.

A block of ground 650 ft. long by 135 ft. wide has been leased from the Jumbo Extension by the Goldfield Consolidated and the production of copper-gold ore has been started for the flotation-plant. The ground adjoins the Clermont mine and is worked from the 710-ft. level. A small shoot of bonanza ore was discovered here a few days ago. Ore for the flotation-plant is at present coming principally from the Laguna, Mohawk, and Red Top mines, but within a short time 100 tons will be treated daily for the Atlanta Co. Until a large and dependable supply of flotation-ore has been assured the company will operate only one 500-ton unit. Lessees are sending considerable ore to the cyanide department of the mill, with some high-grade ore coming from the Mohawk and Red Top.

The recent discovery in the Jumbo Junior at a depth of 880 ft. is stated to be developing well. The vein has been intersected at two points, 50 ft. apart, and has widened from two to three feet. It is planned to start early shipments to the Goldfield sampler. The ore is stated to assay from $50 to $290 per ton in gold and silver and the vein is trending toward the Lone Star.

The Silver Pick Co. is making a final effort to find profitable ore west of the Columbia Mountain fault. From the 1100-ft. level extensive cross-cutting and driving is proceeding, and the vein-material is said to show small quantities of gold and copper. Core-drills indicated the presence of profitable ore in this territory last fall.

With more than 20 companies active the Manhattan district is one of the busiest in Nevada. Operators are planning a stock-exchange, and the construction of new buildings has been ordered, including a large hotel. Many old properties that have lain idle since the collapse of the first excitement are being rejuvenated, and some attention is being paid to the copper deposits found outside the gold-bearing belt.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ARIZONA

Santa Cruz County

J. H. Verfuth is operating the Wandering Jew mines in the Tyndall district in the Santa Rita mouutains. A new road to the mines has been completed, and the mill has been removed from the Salero Flat to the mine. The ore now goes directly from the mine to the rock-breaker and thence to the stamps. Formerly the ore was packed down the mountain by animals on a trail. The mill is being enlarged and additional machinery placed. A new vein of rich lead-silver ore has recently been developed, and the Wandering Jew soon will become a steady and profitable producer.

Yavapai County

The Loma Prieta property comprises 498 acres (27 claims) located in the Copper Basin district, about 12 miles west of Prescott.

The property is within six miles of the railroad at Skull Valley, which is reached by wagon-road. The smelter at Humboldt, 40 miles from the mines, affords a good market for ore and concentrate. Adjoining this property and interlocking with it is the Commercial Mining Company's property, controlled by Phelps, Dodge & Co., and from which 50 to 100 tons of ore per day is being mined and shipped. The buildings consist of a shaft-house, machine and blacksmith-shop, and boarding-house. The property is equipped with heavy hoisting-machinery, 60-hp. boiler, pumps, Leyner compressor, drills, and all equipment necessary for the present operations.

The main shaft is down 420 ft. and is being rapidly pushed to the 500-ft. level. A station was cut at 390 ft. and driving is in progress. The shaft has been in pay-ore from a depth of 62 ft. to the present depth. At the 140-ft. level two drifts were run in opposite directions with cross-cuts for 200 ft. The drifts at the 400-ft. level are in ore running from 3% to 5% copper for over 80 ft., while ore assaying over 20% in copper and $1.60 in gold and silver is being opened up in increasing quantities. A. B. Peach is superintendent of the Loma Prieta mines and for seven years was superintendent of the Phelps-Dodge property, immediately adjoining the Loma Prieta.

CALIFORNIA

Calaveras County

(Special Correspondence.)—The Drake group of claims, including the Last Chance mine, just south of Angels, is to be unwatered and worked by Eastern people. The old shaft is over 1400 ft. deep and it is reported orders have been placed for hoisting and pumping-machinery. The Drake property covers the largest area of any in the Angels field.

A small test-mill is being erected at the Calaveras Consolidated mine, rejuvenated by W. J. Loring and associates. The mill will be followed by a large plant as soon as the best method of treatment has been determined and sufficient ore is available. Driving of the main adit is proceeding rapidly with much good ore reported.

The Lightner mine has been examined by Alex Chalmers and Short & Langham of San Francisco, and it is said work will be resumed. The Allison, Dolling (North Star), and other old producers are being examined in the interest of San Francisco people.

It is reported that good ore has been struck at a depth of 800 ft. in the Tullock mine, on Albany Flat, which is being operated by the Lane interests. The ore is of milling-grade and plans are said to be under consideration for erection of a mill.

The Utica Mining Co. is operating its Gold Cliff and Utica mines and keeping both mills running at full capacity. Developments in the Gold Cliff are reported as particularly satisfactory.

The Levensaler-Speir syndicate of San Francisco is working a number of chrome and manganese claims in the southern end of this county, and also in Tuolumne. Several properties are stated to be about ready for small shipments. Fred Walker is manager.

Angels, April 26.

Mariposa County

A number of men lost their lives in the Mountain King gold mine, several miles above Bagby, near the Merced river on April 29. It is stated that the accident was due to the shutting off of the power, caused by the breaking of the ditch or flume carrying water to the power-plant. Press dispatches stated that the men were overcome by foul air, and were unable to escape from the mine workings. The night-shift worked on the 1400-ft. level of the mine as usual, and fired a round of holes on coming off shift, at about 3 a.m. Sunday morning. A number of men of the day-shift were sent to repair the broken flume, and several others were directed to go into the mine and make some repairs to the track on the adit-level. They were warned against going below the adit-level, as it was thought the bottom of the mine was filled with gas from the blasting during the night. Ignoring these instructions, some of the men climbed down the ladders to the 1400-ft. level, and as a consequence were asphyxiated by the deadly gas that filled the bottom of the mine.

As quickly as possible the flume, which had been torn out to make the necessary repairs, was replaced and the water turned in again. This supplied the necessary power for ventilating the lower workings. Meanwhile, every effort was made to rescue the men who had been suffocated by the gas, and some of the rescuers themselves were overcome and in turn had to be rescued. Finally, by the use of helmets the bodies of seven men were recovered and brought to the surface.

The mill at the Mariposa mine will soon be crushing rock taken out by those working around Mariposa under leases from the company. It is reported at Mariposa that the Mariposa Grant has been sold to Eastern men.

Mono County

(Special Correspondence.)—A promising discovery of molybdenite has been made seven miles east of Masonic by Amigo & McLean, and shipments are being made to Eastern steel-mills by way of Hazen. The ore is high-grade and several claims have been located on the strike and prospecting has begun.

A silver-gold vein 8 ft. wide has been intersected by the adit on the Silverado claim of the Nevada Progressive Co. Assays average around $100 per ton. Thomas Hobb, engineer in charge of the Western Pacific survey of Beckwith pass, has been retained as consulting engineer. Construction of the mill is about to start.

The Masonic Gold Mining & Reduction Co. is driving an adit to intersect the main orebody and has arranged for extensive summer operations. L. J. Cockburn, of Denver, is president and general manager, and Frank Strohm is superintendent.

Masonic, April 28.

Nevada County

(Special Correspondence.)—The new 10-stamp mill of the Columbia Consolidated Mines Co., 3 miles above Washington, is running steadily on ore averaging $7 per ton, and crushing 35 tons per day. The vein is from 2 to 10 ft. wide but the ore contains about the same value throughout, the varying width of the vein seeming to have no important effect on it. The shaft has reached a depth of 300 ft. and is to be sunk to 500 ft. A compressor is run by water-power, direct, all other machinery being run by electricity. A new electric hoist has arrived at the mine and will be put in place at once. The company built a mill last summer but it was scarcely completed before it took fire and was entirely destroyed. The mill now on the property was built immediately after the fire and is to be enlarged by the addition of 10 more stamps. The ore is practically free-milling, as it contains only a small amount of sulphide, and as this is worth only $25 a ton no effort is made to save or treat it as concentrate. E. C. Klinker is managing director and general superintendent. The property is owned by Honolulu capitalists.

Nevada City, April 26.

It is reported that representatives of the North Star mine, of Grass Valley, are examining George Rogers' prospects in Brandy Flat, a short distance west of Washington. These prospects have shown up well, and good rock has been taken out.

Joe Foise & Co. are working nine men at the mouth of Poorman's creek, one mile below Washington. They have a machine to work over the old tailing of the Forty Nine hydraulic mines at Red Point, and are also driving an adit into Red Point.

Plumas County

The difficulty of getting supplies into the Robinson mine at Granite basin has caused the camp to be closed until the roads are opened for easier transportation. Operations on a large scale are expected this summer. The roads are seldom passable before the middle of June, and last year the ice and snow had to be blasted out in some places early in July, in order to get machinery to the mine.

Riverside County

The final payment of $15,000 on the Horn mine was paid into the Commercial Bank of Parker last week to the credit of the former owners of that property, J. E. Kelton and Michael Horn, says the Parker *Post*. The total purchase price, it is said, was $25,000, $10,000 having been paid to the owners in previous payments. It is understood that a large development fund has been placed in the treasury. Extensive work has been started at the property, and from the showing developed to date the Horn property has every indication of becoming a steady producer of copper within a few months.

The company was organized by W. H. Tharpe six months ago, and through his persevering efforts it is now successfully financed.

San Bernardino County

The following notes are from the State *Miner*, of Randsburg:

Several hundred men are rushing the construction of another million dollar borax and potash-plant with two 500-kilowatt steam-turbines at Trona.

Work has commenced on manganese properties near Ludlow by lessees. It is one of the biggest known manganese deposits in the State.

A carload of machinery for W. W. King, lessee of the Buckboard mine, 5 miles south of the Yellow Aster mine, has arrived at Johnnesburg, and is being hauled to the mine. The Buckboard has been a producer in the past.

Shasta County

(Special Correspondence.)—The electrolytic zinc-plant of the Mammoth Copper Co. has been completed and the production of zinc will probably commence about May 15. Sections of the plant are being tested and the different departments synchronized. Visitors are not admitted to the works and the buildings are protected by a high barbed-wire fence, and the single gate is guarded both day and night. H. R. Hanley, inventor of the process, after seven years of experiments at the Bully Hill smelter, near Winthrop, will be in charge of operations. The plant is designed to extract zinc and other metals from the flue-dust arrested by the bag-house, and to recover metallic zinc from crude ore. Its construction represents an approximate expenditure of $350,000.

The Accident group of quartz claims, six miles west of French Gulch, including the Sybil mine, has been sold to the Shasta Hills Mining Co. The deal unites conflicting interests, which will facilitate operations. It is stated that some good ore is exposed.

Lumber for the flotation-plant of the Afterthought Copper Co. is arriving at Ingot and construction of numerous mine-buildings is proceeding. Three auto-stage lines are operating between the camp and the railroad, and upward of 100 men are employed in and around the mine. The projected flotation-plant is to cost approximately $100,000.

It is reported that the Balaklala Copper Co. will ship from its Coram mines to the Mason Valley smelter at Thompson, Nevada, as soon as the second furnace is blown in. At present 300 tons of ore is going daily to the Kennett smelter and recent work in new territory has been satisfactory.

Gus Bauer and associates, of Redding, are prospecting on the east side of the Sacramento river for oil, for which purpose $5000 has been raised. Occasional pockets of natural-gas have been reported in this field in the past and several test-mills were drilled near here about 1900.

Kennett, April 30.

Siskiyou County

(Special Correspondence.)—R. N. Burgess last week announced that plans for the building of a railroad from Grenada to Fort Jones had been approved and that construction of the line in the immediate future was assured. The railroad will be 60 miles long, and will traverse one of the richest mineral regions of the State. Branches are to be extended to Etna Mills and Scotts Bar. The districts through which it will pass contain numerous deposits of gold and copper, and a lack of transportation facilities has been the principal factor against extensive development and production.

The Siskiyou Syndicate has arranged for more vigorous work at its Cub Bear and Blue Jeans mines, above Etna Mills, and plans the building of a small experimental-plant at the Blue Jeans. Both mines have been under development for more than six years and much profitable ore is said to be blocked out. Seattle people are heavily interested.

Driving of a 600-ft. raise to connect the lower and upper adits has started at the Mt. Vernon gold mine, nine miles from Yreka. The orebody was intersected at a depth of 900 ft. by the main 600-ft. adit and it has been opened by drifts for 800 ft. The main vein is over three feet wide with free-milling ore. Stringers of rich ore accompany the vein. J. S. Dobyns is superintendent.

At a depth of 200 ft. in the Know Nothing mine a shoot of rich ore has been discovered. It ranges from one to three feet wide and shows much specimen quartz, assays running from $50 to $600 per ton. The mine was recently acquired by W. L. Beall, of Yreka, after having been abandoned for 16 years. Late work shows that the former owners missed the vein by two feet while sinking.

R. A. Lewis of Yreka has bonded his placer holdings to a company of Oregon and Idaho people, and the old Fairchild shaft will be sunk 50 ft. deeper to open the Blue Gravel channel, believed to course through the property. Orders have been placed for two large pumps.

Yreka, April 23.

TULARE COUNTY

(Special Correspondence.)—The Magnesite Refractories Co. of Porterville, has recently been reorganized and incorporated under the laws of Nevada. The new president is Ed DeMoulin, and E. W. Skinner is the secretary-treasurer. These, with W. H. Fuller, compose the new board of directors. H. L. Voss, formerly with the Porterville Magnesite Co. of this district, is local manager. The new corporation has opened an office in the Marsh-Strong building, Los Angeles. The original company had leased considerable foot-hill property, north of Porterville, from which magnesite is being mined. They are also buying custom ore in order to fill their Eastern contracts. As soon as the Visalia Electric railroad, which is constructing a line in that vicinity, builds a spur-track to the property, the company will erect a calcining-plant. The company has thousands of tons of magnesite on its dumps, and at other places upon its property. It is the intention also to bid on furnishing crushed-rock for the building of the system of highways throughout the county for which $2,200,000 bonds were recently voted.

Porterville, April 26.

TUOLUMNE COUNTY

(Special Correspondence.)—A new body of ore has been discovered in a winze below the south drift on the 1800-ft. level of the Black Oak mine, at Soulsbyville. At the point of discovery the orebody was narrow, but in sinking it has widened rapidly. Recently a rumor gained circulation that the property was to suspend operations, owing to the increased cost of materials, but this has been emphatically denied. A company of local mining men are operating the Driesam mine, at Arastraville, under bond. Considerable development work has been decided upon.——The force at the Dutch mine near Jamestown was recently augmented to expedite the work of preparing for the extensive changes and improvements to be made in the plant.——An electric-hoist has been installed at the Yosemite mine and better progress is being made in sinking the shaft.——Extensive improvements are contemplated at the lime-plant of the Pacific Lime & Plaster Co., one-half mile south of Sonora. The capacity of the plant will likely be greatly increased.

Sonora, April 21.

COLORADO

CLEAR CREEK COUNTY

Pomeroy and Grenfell, lessees on the old Shively mine above Silver Plume, have the returns from their first shipment of ore this week. The ore ran 321 oz. silver per ton and 7% lead. This high-grade ore is in keeping with the past reputation of the mine, which was a large producer in the early '70s, and later, under the management of Warren Fletcher, who worked the property for several years successfully until the demonetization of silver. The property is owned by the Bank of Clear Creek County and has been idle for a number of years, and, although it was well known that it still contained bodies of high-grade ore, the price of silver up to last year would not permit of the mine being operated profitably.

The lessees took the property a little over a month ago and have had to do considerable dead work in cleaning out the levels.

This, their trial shipment, however, proves that their faith in the mine was well founded, and from now on a steady shipment may be looked for.

MISSOURI

JASPER COUNTY

Lead production is the most important programme on the tract of the Lone Elm Development Co., of the Granby land, north-west of Joplin. Numerous companies are making good jack turn-ins, but the good price for lead has spurred many operators to turn their attention to this ore exclusively, with the result that more lead is being produced from the property than for many years.

One of the most successful lead producers is Bell & Company. They are making approximately 20,000 lb. of galena and 15,000 lb. of drybone weekly, with a small equipment and a minimum expense.

Close to this tract the Alkali Ike company is sinking a new shaft with a prospect of finding the same run of lead being worked by Bell & Company, and on the other side Stevens, Roper & Company are sinking a shaft for the same purpose.

Hulett & Company are in a rich lead-bearing formation at a depth of 40 ft. and are getting both galena and drybone.

J. Van Skoyt has a lead prospect at a depth of 60 ft. and has started construction of a steam-rig.

Bailey & Company are producing regularly both lead and zinc at a depth of 90 feet.

The Lincoln Mining Co. is producing regularly from the old Van Skoyt diggings and is getting a good recovery.

Ball & Company and Enderline & Moser are each sinking new shafts on Lead Hill. Prewitt & Company are driving at 40 ft. in fine-looking lead ground. Dobbs & Daugherty are sinking a new shaft and are finding good shines and expect to get into the ore in a few days.

NEVADA

ESMERALDA COUNTY

During the month of March, the total production of the Goldfield Consolidated Mines Co. was 27,000 tons, from which resulted a net realization of $19,727.89. During the month 1453 ft. of development work was performed at a cost of $6.73 per foot.

The operating costs were as follows:

	Ore handled per ton	Total ore per ton
Mining:		
Stoping	2.641	
Development	23.519	
Total mining	3.086	2.483
Leasing expense	3.005	0.063
Dump-moving	0.410	0.069
Transportation	0.067	0.067
Milling	1.910	1.910
Marketing	0.040	0.040
General expense	0.357	0.357
Bullion-tax	....	....
Filter-royalty	0.027	0.027
Flotation-royalty	0.044	0.044
Surface	0.053	0.053
Total operating costs		5.113
Miscellaneous earnings		0.072
Net operating costs		5.041
Construction		....
Net costs		5.041

On the 130-ft. level of the Combination mine, 210 tons of $20 ore was produced. In the Mohawk, on an intermediate level above the 350-ft. level, 116 tons of ore was mined in cutting the sill-floor. This ore assayed $43.41 per ton. In the La Luna, on the 600-ft. level, 93 tons of $153 ore was taken from a winze. During the month lessees produced 563 dry tons of ore having a gross value of $9727.36 of which the company received $5994.99, less cost of transportation and milling.

MINERAL COUNTY

(Special Correspondence.)—The mines of the Luning district are looking exceptionally well, according to John C. Skuse, who has operated there for some years. Mr. Skuse

speaks particularly well of the St. Patrick mine, recently acquired by the Kirchen Mines Corporation. Regular shipments are being maintained, and new buildings are being erected to house the larger crew that will be put to work as soon as they are finished. The winze that is being sunk from the 100-ft. level of the Nevada Champion is in splendid ore, the ore-shoot, which has been followed from the surface, has improved as depth has been gained. The Wall Street Turk mine is among the steady shippers and the management has recently inaugurated an elaborate system of development which is producing good results.

Luning, April 27.

(Special Correspondence.)—Sinking of the double-compartment shaft of the Queen Regent Merger mine has advanced to the 470-ft. point and is expected to cut the main orebody at any time. Sulphide ore has been showing from the 450-ft. workings. Sinking will continue to the 600-ft. level, from which point extensive lateral work will be undertaken. This is the mine that attracted much attention about a year ago by several shipments of specimen ore. The management claims the world's record for sinking a double-compartment shaft 400 ft. deep at a total cost, including timbering and development, of $12 per foot.

The La Patt copper group, commonly known as the Copper Mountain, is being developed by the Jumbo Extension Co., of Goldfield. Twenty men are on the payroll and sinking of the No. 2 shaft is proceeding rapidly with good ore showing. Twenty-five lessees are also active and from the Miller-La Patt lease are shipping weekly three to four cars of ore assaying 10 to 17% copper, together with some gold and silver.

The Nevada Rand Co. has sunk the shaft on the Last Hope mine to a depth of 430 ft. and will cross-cut as soon as the 450-ft. level is established. This work is expected to intersect the vein which yielded rich ore near the surface.——About 35 teams and several motor-trucks are engaged in hauling ore and supplies between the Rand district and Nolan.

Rand, April 28.

Nye County

(Special Correspondence.)—The Louisiana Consolidated Mining Co. is sorting the dump at the main-shaft of the Tybo mine and soon will have a carload ready for shipment that will run better than $175 per ton. This dump, which contains 4000 tons, came from a drift on the vein at the 400-ft. level. The best of the ore was shipped at the time it was mined but it is believed that the entire 4000 tons left will average $50 per ton. Grab-samples of the finer stuff shows that it will run $35.76 per ton, while a second-class dump is being piled up in addition to the high-grade mentioned. The 400-ft. is the lowest level that has been opened in the Tybo mine and the average values were 64% higher than on the 300-ft. level and above. It is the intention of the Louisiana company to start sinking as soon as the mine is unwatered, which will probably be along the last of May.

Eureka, April 20.

(Special Correspondence.)—The White Caps Co. has arranged to sink the shaft 125 ft. deeper, which will give an approximate vertical working-depth of 600 ft. Work on the fourth level has established the junction of the West and Shaft veins. The West vein on this level has been proved for a length of 70 ft. and has an average width of 15 ft. Its limits at this point have been established. The roaster is being installed in the mill. Building of a road to connect the mine with the Manhattan-Tonopah highway will start in a few days.

At the Morning Glory an electric-hoist is in position and sinking has begun. Hand-drills are being used but an order has been placed for a four-drill Ingersoll-Rand compressor. The management expects to reach the orebody within 50 ft. Meanwhile, a segment of the Consolidated vein-system is being developed near the surface.

Sinking at the Manhattan Consolidated has reached a depth of 295 ft. with the bottom in crushed shale carrying quartz stringers. Expecting that a heavy flow of water may be struck near the orebody, a No. 6 Cameron pump is being installed.

East and west drifts are advancing from the 600-ft. level of the Union Amalgamated. The east drift is expected to intersect the Earl vein-system about 300 ft. distant. The east drift has cut an ore-shoot 3 ft. wide, assaying $16 per ton.

The Thelma, White Caps Extension, and Cash Entry groups have been merged into a company controlled by John G. Kirchen, Jesse Knight of Salt Lake, and other Nevada and Utah people. The territory lies near the White Caps mine and will be developed under supervision of John G. Kirchen.

Manhattan, April 28.

Storey County

The new development on the 2700-ft. level of the Mexican mine continues to look well. Recently five cars sampled over $99, and four cars ran $132 per ton. On the 2700-ft. level of the Consolidated Virginia ore is being stoped across a width of 10 ft., the average value being $14 per ton. There are new and promising developments in the Sierra Nevada mine. Years ago some good ore was found there near the Union line, but it was not developed. Recently a drift was run to reach the ore and the rock broken begins to look well.

NEW MEXICO

Grant County

The 85 Extension Copper Co., has taken over the Atwood mine at Lordsburg, and is preparing for continuous production. The recently installed electric-pumps will have unwatered the workings by the middle of the coming week.

Luna County

(Special Correspondence.)—The Empire Smelting & Refining Co. will operate a lead-smelter at Deming. The furnace will be blown-in May 1. A concentrating-plant also is being installed for the treatment of ores of vanadium and molybdenum.

Deming, April 26.

Santa Fe County

A sale was recently made by John O. Jones of the Anna Jones group of mining claims, also the sale by T. Z. Winter of the adjoining group. The entire eastern part of Santa Fe county, north of the line of the Atchison, Topeka & Santa Fe railroad, is known to be rich in copper, gold, and silver, while it is also known that some of the rarer metals exist more or less abundantly. The majority of the known properties are located on or near a contact between the granite and lime which traverses the county in a north-east direction. The Anna Jones group is situated on the high mountain ridge between Indian creek and the north fork of the Macho.

Socorro County

(Special Correspondence.)—Louis Gramas has opened a 3-ft. breast of mill-ore in a lower tunnel on his Gold Eagle group and is preparing to make a shipment to custom works.

The Socorro Mining & Milling Co. produced 18 bars of gold-silver bullion during the first half of April. The bullion product of the Mogollon Mines Co. for the same period was 15 bars.

The Oaks Company has developed a good back of ore above the adit on the Maud S mine. Ore-bins have been completed, track laid, and ore-chutes placed in readiness for economical handling of ore. The trail to the Socorro mill is finished and it is planned to begin extensive production at once.

After years of effort this district is to have a new outlet by way of the lately created State-road across the divide from Mogollon to Magdalena. Funds for the construction are available from both the Forest Service and the State treasury, and it is understood that work is to start at once. In addition to

facilitating various lines of business this road has unusual scenic features, traversing a wide area, most of which is in its original state.

Mogollon, April 24.

OKLAHOMA

Craig County

Seventeen armed under-sheriffs are employed by the Commerce Mining & Royalty Co. in guarding its properties in the Oklahoma field. Some other companies have guards and more will put them on, according to recent reports. Safeguarding the plants is considered not only necessary for personal property protection but as a national duty.

In the Wisconsin zinc district members of the State militia have been stationed at different points, since there have occurred explosions at the powder houses of two different company storehouses. It is stated that there was no evidence to show that the explosions were other than accidental, but mine-owners have asked for protection for their properties and have been granted it.

Protection of the powder-making industry, so closely allied with mining in this field, is being thoroughly worked out. At the plant near Columbus, Kansas, H. F. Donnelly, superintendent, recently gave out an interview refuting a rumor that guards employed at the plant are not armed.

"The guards are armed and have orders to fire after a single command to halt is disobeyed," says Donnelly, who also explains that the guards have regular trips to make about the plant and along the company's railroad track. Clocks have been distributed at different points along the beats and watchmen must register on schedule. If any guard is more than ten minutes late in reporting, other guards start out to investigate the cause of the trouble.

Due to decreased demand from the mines, the plant shut down April 1, and will not be in operation again until May 1, the time being used to make needed repairs.

OREGON

Jackson County

(Special Correspondence.)—In the spring of 1916, John McRunnels and Dick Swacker, miners of Gold Hill, while tracing for the source of fine gold in the soil, uncovered a promising vein, six miles south-west of Gold Hill, and west of Rogue river. It is within a mile of the river, and about 300 ft. above the bed of the stream. The discoverers uncovered the vein, and within a few feet of the surface, found a pay-shoot, which extended for 150 ft., with a depth of from 10 to 35 ft. They recovered about $1000 in gold from this shoot; the vein was from 3 to 12 in. wide. It strikes south 80° west and dips 20° north. The hanging wall is porphyry, and the foot-wall diorite; the vein is composed of crystal and decomposed quartz, and is free-milling. The discoverers refused several offers, and later were unable to agree as to the manner of developing the prospect. Recently McRunnels sold his interest in the property to John T. Donegan, a local miner. The present owner is preparing to sink a shaft on the vein to demonstrate the worth of the property.

Gold Hill, April 28.

UTAH

Beaver County

(Special Correspondence.)—The Utah Leasing Co. is operating a 500-ton flotation-plant, treating tailing from the old South Utah Mines & Smelters concentrator. An additional 8-ft. by 30-in. Hardinge ball-mill is being put in and will be ready about April 25. In connection with this a 20 by 20-ft. and a 10 by 50-ft. Dorr thickener, for thickening concentrate, are being erected. At this plant 30 men are regularly employed.

Newhouse, April 18.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

Malcolm Maclaren is in Peru.

H. R. Norsworthy has gone to Plumas county, California.

Richard A. Parker was at Breckenridge, Colorado, last week.

Benjamin Rezas is visiting mines in Shasta county, California.

Kent E. Keller, of Ava, Illinois, formerly in Mexico, is visiting California.

Frank A. Bird is manager for the firm of R. H. Officer & Co. at Salt Lake City.

H. C. Hoover has been elected an honorary member of the Canadian Mining Institute.

J. G. Dickenson and P. McDonald have returned to Cobalt, Ontario, from Prescott, Arizona.

E. C. Bauer is now assistant to the vice-president of the American Manganese-Steel Co. of Chicago.

R. S. Baverstock has been in Silver Peak district, and has now gone to Lida and Hornsilver, Nevada.

Thomas M. Bains, Jr., has resigned as Instructor in Mining in the Case Institute and is now at Berkeley.

E. C. Klinker has returned from Honolulu to the Columbia Consolidated Mines, at Washington, California.

Brent Neville Rickard has been transferred from the Murray plant of the American Smelting & Refining Co. to the Tacoma plant.

Henry M. Howe has been awarded the John Fritz medal and will receive it at a presentation ceremony to take place at the United Engineering building, New York, on May 10.

F. N. Flynn, general superintendent of the Chile Exploration Company, at Chuquicamata, Chile, has severed his connection with that company and is due to arrive at New York.

C. R. Richards, professor of mechanical engineering, has been appointed dean of the College of Engineering and director of experiment station of the University of Illinois, in succession to Dr. W. F. M. Goss, who has resigned to become president of the Railway Car Manufacturers Association of New York.

The Peruvian government has granted a concession for explorations for gold and ore in the rivers of Marcapata, Nusiniscato, Huayllumbe, and Crayumayo. The concessionaire, Juan C. Diaz, will begin explorations in the beds and banks of these rivers and their affluents within six months, and terminate the work within two years. El Peruano gives the terms of the concession, stating the privilege of the concessionaire to work certain of the auriferous deposits, with the payment of 10% of the net profits from such mines to the

Steel and copper will win the War for the United States, says the Boston *News Bureau*. The United States has a capacity for turning out from 45,000,000 to 50,000,000 tons of steel ingots per year. Great Britain, France, and Russia have a capacity of about 20,000,000 tons. Germany's capacity, under war conditions, is not much over 17,000,000 tons. The United States and Allies have a combined capacity of over 65,000,000 tons, not including Japan, or nearly four times the steel capacity of Germany. Nearly all the copper that is being produced in the world today is being refined in this country. Steel and copper will win the War.

THE METAL MARKET

METAL PRICES

San Francisco, May 1

Antimony, cents per pound	23
Electrolytic copper, cents per pound	37
Pig lead, cents per pound	9.25—10.25
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$110—111
Spelter, cents per pound	12
Tin, cents per pound	55
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, May 1

Antimony, 50% metal, per unit	$1.80
Chrome, 40% and over, f.o.b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tungsten, 60% WO_3, per unit	18.00—20.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 45% (under 35% metal not desired), cents, unit	36—38

Buyers of manganese ore transact business on a basis of the long ton of 2240 lb., for which the present price is $19 per ton for 45% ore. For each additional per cent 65c. is paid above the base rate, and the same deduction, of 65c., is made for each unit below 45%. Thus for an ore running 48% MnO_2 the present price is $19 + $1.95 = $20.95, and an ore containing 42% MnO_2 is worth $19 — $1.95 = $17.50. Ore running under 35% MnO_2 is not wanted. A silica content up to 8% is permissible. A penalty of 50c. per unit is taxed on silica over 8%, up to 15%. If containing more than 15% the ore is not marketable.

EASTERN METAL MARKET

(By wire from New York)

May 1.—Copper is firmer, from 30.25 to 31c. Lead is stronger at 9.50 to 9.75c. Spelter is more active at 9.25 to 9.50 cents.

Platinum remains unchanged at $105 to $111.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
Apr. 25	73.50	Mch. 20	72.91
" 26	73.50	" 27	72.06
" 27	74.12	Apr. 3	72.98
" 28	74.12	" 10	73.72
" 29 Sunday		" 17	73.27
" 30	74.75	" 24	74.08
May 1	74.37	May 1	74.06

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	72.51	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

Public interest has been aroused by the recent changes in the price of silver, and with the interest displayed the question arises as to the extent of the world production of the metal.

Within the last two years there has been a phenomenal rise in the price of silver, a rise which started from an extremely low level—for the lowest quotation of 1915 of 45.6c. an ounce was only 1.7c. above the very lowest quotation (in 1902 and 1903) ever recorded on the silver market. At the outbreak of the War silver slumped from 56c. an ounce to 45c., and remained between 44 and 46c. up to February 1915. Late in 1915 an advance commenced and continued until 75c. was reached in May 1916. There was a sharp reaction to 58c. in July, but by the end of the year 75c. was again reached. The market remained firm, and quite recently the price hardened to about 77c., a higher quotation than in any year since 1893.

The world's production of silver in 1916 was 177,400,000 fine ounces, of which the United States contributed 72,900,000 ounces.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
Apr. 25	30.25	Mch. 20	35.87
" 26	30.30	" 27	35.62
" 27	30.30	Apr. 3	34.58
" 28	30.25	" 10	33.83
" 29 Sunday		" 17	32.75
" 30	30.50	" 24	31.47
May 1	31.00	May 1	30.43

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	33.16	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

The six largest disseminated-copper mines of the United States during 1916 produced 600,000,000 lb. of copper, which is about 25% of the entire production of the country. The average cost of this copper was 8.6c. per lb. The net profits of the six companies operating these great mines was $108,730,000, from which dividends to the amount of $51,000,000 were paid. To accomplish this 24,000,000 tons of ore was mined and treated. By far the greater part was mined in open-pits by means of steam-shovels, the ore being concentrated and the concentrate shipped to smelters for reduction.

The companies above referred to and the amounts of copper produced by each, the cost of production, the amount of ore still held in reserve, and the average estimated copper content is shown in the following table:

	Copper, lb.	Cost per lb., cents	Ore reserves, tons	Av. copper content, %
Utah	187,531,824	6.920	369,845,558	1.41
Inspiration	120,772,637	8.673	91,789,120	1.63
Nevada Con.	90,735,287	10.170	67,993,117	1.59
Ray Con.	74,983,540	10.267	93,373,236	2.03
Chino	72,319,508	8.706	95,555,843	1.65
Miami	53,518,331	9.520	50,400,000	1.82
Total	599,861,127	8.600	768,956,864	1.60

These great mines doubtless will be called upon heavily to supply copper to the Government during the term of the War, but no one doubts their ability to comply with the heaviest demand that may be made upon their resources, which, as indicated above, approximates a billion and a half tons of ore, containing on an average about 1.5% copper, or about 22,500,000 tons of metal.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
Apr. 25	9.50	Mch. 20	9.75
" 26	9.50	" 27	9.50
" 27	9.50	Apr. 3	9.40
" 28	9.75	" 10	9.35
" 29 Sunday		" 17	9.35
" 30	9.75	" 24	9.43
May 1	9.75	May 1	9.62

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	9.38	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

The Hecla Mining Co. of Idaho, on April 20, declared dividend No. 167 of 15c. per share, being $150,000. Total for 1917, $600,000. Total paid to date, $5,905,000.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date		Average week ending	
Apr. 25	9.25	Mch. 20	10.69
" 26	9.00	" 27	10.74
" 27	9.00	Apr. 3	10.71
" 28	9.25	" 10	10.64
" 29 Sunday		" 17	9.87
" 30	9.37	" 24	9.58
May 1	9.50	May 1	9.23

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	10.20	Oct.	14.05	9.92	....
May.	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date	Week ending		
Apr. 3	115.00	Apr. 17	115.00
" 10	115.00	" 24	113.00
		May 1	113.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	114.50	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	48.25	51.49	55.63	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Eastern Metal Market

New York, April 25.

The metals are divided into two camps—the strong and the weak. Two of the leading ones are weak and two are strong. Because of light transactions in some, the quotations are nominal, but the entire situation is uncertain, dominated by war conditions in our own country, and by lack of definiteness as to just how much metal the Government will buy.

Copper is nominal and lower on offerings of small lots.

Zinc continues weak and declines almost daily.

Lead is strong and firm, with sellers holding aloof.

Tin is higher, with a fair business reported.

Antimony is dull and a little lower.

In the steel market the amount that the Government will want the first year exceeds the first estimates. It is now put at 1,000,000 tons of plates, shapes, and bars. Already Government business taken at Pittsburg amounts to 100,000 tons of plates. The indications are not favorable to the extension to the Allies for their last half needs of the low prices granted the U. S. Government on steel and copper. The feature of the week was the statement of the U. S. Steel Corporation for the first quarter this year, showing net earnings of over $113,000,000 and an extra dividend of 3% on common stock, making it 4½% for the quarter. Rail buying into 1919 has developed, and price advances on finished steel continue to appear.

COPPER

With the market still declining on offerings of small lots, and with almost no business transacted, there is not much that can be said. There is absolutely no interest on the part of buyers for any position. While it is manifestly a buyers' market, the buyers will not nibble, offerings of metal at 25c., New York, for far future delivery causing no enthusiasm. Large and small purchasers are merely looking on and waiting to learn the actual needs of the Government and the Allies. All kinds of speculation as to these requirements is heard, both as to quantity and particularly as to price, but nothing definite is known. Producers are well sold up to July 1, nearby metal being obtainable only in small quantities as re-sale lots. The March exports, just made public, were large—45,327 gross tons, against 32,265 tons in February this year; 26,231 tons in March, 1916, and 30,148 tons in March, 1915. The London market is still declining, yesterday's quotation for spot electrolytic having been £142, a decline of £5 from that of last week, and £9 per ton from that of two weeks ago.

LEAD

The metal is strong and active so far as inquiries are concerned, but the inclination of sellers is to hold back. The absorbing topic is the probable needs of the Government. These are not definitely known, but rumors based on fairly definite information place them at figures which will surprise the trade when made public. The army's needs will more than double those of the navy, and the total will exceed the largest estimates. The entire week has been characterized by a strong undertone, with the demand greater than the supply. Spot lead is scarce. Sales the last of last week were fairly good under the conditions. The quotation yesterday was 9.30c., St. Louis, or 9.50c., New York, for spot and April metal, with higher prices probable in the near future. The American Smelting & Refining Co.'s price is still 9c., New York. The London quotation yesterday was £30 10s. for spot metal.

TIN

There have been no more developments regarding the proposed Government tax of 10% on tin imports and the trade continues to believe more firmly that this will not be imposed. The week has been generally dull, but the tone strong, especially yesterday and Monday. On April 18 the market was quiet, with sales of about 150 tons reported, mostly futures, with few sellers concerned. On April 19, in a dull market, about 100 tons of nearby tin went to one concern. Spot Banca tin was sold on April 20 at 54.50 to 54.75c. with most of the day very dull but more active inquiries appearing toward the close. On Monday the announcement of an increase of 2% in the war insurance-rate, making it 5%, caused a sharp advance, spot Straits selling on that day and on Tuesday at 57.50c., due to this increased rate. The explanation offered is that there have been probable sinkings of tin-laden ships, known in London, because the price advanced there £5 per ton on Monday, which is more than the 2% rise in insurance. The tin afloat at the close of business, April 24, was 2812 tons, with the arrivals at 2040 tons. The London market has advanced sharply to £24 12s.6d. yesterday for spot Straits, an increase of about £7 over last week.

ZINC

In the continued absence of any life or demand the only interesting feature of the past week has been the publication of the U. S. Geological Survey's report of the 1916 output of primary spelter, showing over 667,000 net tons produced or a gain of 37% over the large production of 1915. One prominent dealer points out that if, to the apparent consumption shown by the report, there is added the exports, the total is only 3000 tons short of the output. It is believed that strikes and other causes lately have curtailed the present output. While the market is at present 'sick,' competition for the little business offered forcing prices down, it is regarded as certain by some that a turn will come not long after the Government's requirements are made known. The quotation today for prime Western for nearby and April shipment is 9c., St. Louis, or 9.25c., New York, though probably desirable business would bring out a quotation ½c. lower.

ANTIMONY

Demand for spot metal has quieted down. It can now be obtained for 34 to 34.50c., New York, but the amount available is not believed to be large, and it will be some time before any more may be expected by vessel.

ALUMINUM

The quotation is 58 to 61c. for No. 1 virgin metal, 98 to 99% pure, depending on the quantity and delivery wanted.

ORES

ANTIMONY. For April nearby shipment the quotation is $2.25 per unit, with the market very quiet.

MAGANESE. The difficulties in obtaining regular shipments from abroad are increasing almost daily, and manufacturers here who have relied upon Indian and South American ore are now trying to secure such manganese ore as is produced in this country, Cuba, or Central America in general. Such small lots as actually reach our market have found ready buyers and 85c. was paid on the basis of 45% material.

MOLYBDENUM. The quotation ranges from $2 to $2.25 per lb. of molybdenum contained, but the demand is light and the transactions reported are small.

TUNGSTEN. Sales of fair quantities of concentrate continue to be made at $17 to $18 per unit. Inquiries are reported as heavy during the past week, and higher prices are not unlooked for. Arrivals from South America have not been large because of the scarcity of bottoms. Both domestic and foreign inquiries for ferro-tungsten continue to appear, the quotation for which is from $1.90 to $2.10 per lb. of contained tungsten.

The Bunker Hill & Sullivan Change-House

The Bunker Hill & Sullivan Mining & Concentrating Co. at Kellogg, Idaho, gives much attention to the care of its workmen. A convenient and properly designed change-house is a necessity at every mine, and this the company has provided. The accompanying illustration is an interior view of the upper floor of the change-house, showing some of the clothes-hangers lowered for the removal of clothing, and others hoisted beside the steam-coils for drying. Shower-baths are provided in the individual compartments at the left side of the room. There are also tubs with hot and cold water for washing clothes. Other appointments have been provided to insure sanitary conditions, and with a view to the convenience of the men.

THE BUNKER HILL & SULLIVAN CHANGE-HOUSE, KELLOGG, IDAHO

Mining companies generally are realizing more and more the importance of the proper care of their workmen, and well-appointed change-houses are becoming general.

Rescue Work in Burning Mines

In these days of an ever increasing interest in the health and general welfare of employees, much thought has been given to methods of rescuing men from burning mines, and from parts of mines where deadly gases have accumulated from natural or other causes. Seldom has the utility of the modern rescue-apparatus had a better test of its great value and efficiency than was afforded recently in one of the leading Butte mines. Years ago the heavy mass of sulphide ore in the Leonard mine took fire—how is not positively known, nor is it important, in this connection, but it is of importance that, notwithstanding every effort that has been made to extinguish the fire it still burns, sometimes smouldering slowly and at others with surprising vigor. Sulphurous gas, smoke, and carbon di-oxide at times fill some of the workings and the men not infrequently have narrow escapes from asphyxiation. Not long since, the gas broke into workings where numerous men were employed. Some were on the levels and had a fair chance of escape, but others were up in stopes, and were practically cut off from a quick and easy passage to safety. Heroically the stronger men endeavored to aid the weaker ones, who otherwise must have perished, but in most cases the former were compelled to run to save their own lives, if possible. Rescue apparatus was at hand and one experienced man entered the gas-filled workings and dragged two or three men from perilous positions to places of safety. Other men, who had never worn the apparatus, then volunteered their services. Equipped in helmets and armed with the necessary implements, they descended the shaft with the leader, and by their aid the imperilled men were taken out, some of them more dead than alive, but by the administration of restoratives and application of the various means employed in resuscitating men in such condition, all were saved. The accompanying illustration shows one of the Bureau of Mines rescue cars which is fully equipped and is to be taken from place to place for the purpose of giving instruction to the miners that they may be able promptly to act in just such emergencies as the one above described. How quickly these men may become efficient is shown by the incident above related.

U. S. BUREAU OF MINES RESCUE-MACHINE

Company Reports

ALASKA JUNEAU GOLD MINING CO.

The second annual report of the Alaska Juneau Gold Mining Co., for the year ended December 31, 1916, is as follows:

During the year the greater part of the underground work has been confined to the completion of the plans to prepare the mine for the production of 8000 tons of ore daily. It was decided to start the development work necessary to mine 2000 tons daily from the surface by the open-pit method, in that part of the property lying between the Silver-Bow fault and the East property line. Also to prepare the North orebody for mining operations farther north-west along the strike than had been contemplated in last year's report. The total development done in connection with the general program as outlined was: drifts and cross-cuts, 8958 ft.; raises, 7457 ft.; intermediate drifts, 1986 ft.; powder-drifts, 2645 ft.; stations, 1531 ft. Total, 22,577 ft. As none of the underground work was of an exploratory character, there is nothing to report regarding changes in the general appearance of the mine. The average assay value of all development-work samples taken from the orebodies to December 31, 1916, show for the North orebody 2680 samples, average assay value, $0.802. South orebody, 776 samples, average value, $0.94. For the entire mine, from all levels, 3456 samples returned an average value of $0.832.

Ore was sent to the mill from development work as follows:

	Tons
No. 2 South	2,838
No. 2 North	7,466
No. 3 North	16,119
No. 4 North	20,649
Total	47,072

From No. 4 North 133,041 tons was sent to the mill from the stopes, making a total of 180,113 tons.

The 50-stamp pilot-mill operated continuously throughout the year, but under somewhat restricted capacity during the last few months, during which time there was considerable obstruction to ore tramming on account of the work in connection with double tracking the railroad and the substitution of 50-lb. rails with 40-lb. rails. No work deserving special mention was undertaken in the mill during the year, but a number of problems have been worked out and the knowledge thereby gained has been incorporated in the flow-sheet of the new mill. While the final tailing assays are normal the losses during the year have been abnormal, due to the fact that a large quantity of coarse sand, averaging $0.322 per ton or $0.0328 per ton milled, has been used in connection with the concrete work in the new mill.

INSPIRATION CONSOLIDATED COPPER COMPANY

The annual report of the Inspiration Consolidated Copper Co. for the year ended December 31, 1916, shows the following: Ore reserves, at the end of the year 1915, 97,143,000 tons; mined during the year 1916, 5,353,880 tons. Reserves at the end of 1916, 91,789,120 tons. Of this reserve, 20,000,000 tons is classed as oxide ore. During the year experimental work was carried on to devise a satisfactory method of treating the oxidized ore, and good results were obtained. A suitable small plant is being built to continue these investigations. The last unit to the mill was completed February 21, 1916, since which time the entire plant was in continuous operation. Practically 91% was saved on an average ore assaying 1.548% copper. Two additional sections of the mill soon will be in operation, which will insure a daily capacity of 16,000 tons. The mine can easily maintain a production of 20,000 tons daily. The yield of refined copper was 22.625 lb. per ton of ore; and the cost of copper, exclusive of depreciation, was 8.673c. per pound. The net profit for the year was $20,629,489.30. Out of the net earnings of the year four dividends, aggregating $7.25 per share were declared, being a total of $8,548,050.75. The total mine openings at the end of the year was 60.76 miles. The cost of mining per ton of ore was $0.607; of coarse-crushing $0.02798; of ore haulage, $0.0154; of concentrating and royalties, $0.5038; of concentrate hauling, $0.00145. Total, $1.15576. Smelting, freight, refining, and marketing, $0.79269. Total cost of mining, milling, and treatment, $1.94845. Tonnage treated during the year, 5,316,350 tons; copper produced, 119,431,389 pounds.

CERRO GORDO MINES CO.

The first annual report of the Cerro Gordo Mines Co. includes the interval from October 1, 1915, to December 31, 1916, and is as follows:

CASH RECEIPTS

From sale of silver-lead, zinc, and copper ores	$310,764.61
From sale of slag	40,382.94
From sale of 100,000 shares stock at $1	100,000.00
From sundry sources	8,641.96
	$459,789.51

CASH DISBURSEMENTS

Expenditures for improvements since date of acquisition	$146,056.75	
Labor and supplies	175,717.68	
Miscellaneous	1,263.07	
Dividend No. 1	24,375.00	$347,412.50
Cash on hand and in bank Dec. 31, 1916		$112,377.01

ZINC-ORE PRODUCTION

Last quarter of 1915, 2039.072 tons, containing 1,243,584 lb. of zinc. During the year 1916, 11,264.719 tons, containing 6,968,869 lb. of zinc. The average content of zinc in this ore was 30.93%.

LEAD-ORE PRODUCTION

During 1916 only 1496.831 tons of ore was produced of the following value:

Gold, oz.	Silver, oz.	Lead, lb.	Lead, %	Lead, lb. per ton
20.245	32,246	1,053,426	35.188	703.77

SLAG PRODUCTION

Tons	Silver, oz.	Lead, lb.	Lead, %	Lead, lb. per ton
9431	27,594	2,200,170	11.67	233.291

COPPER-ORE PRODUCTION

Copper ore was produced only during the month of December, 1916, to the amount of 26.675 tons, containing 453 oz. of silver, and 2238 lb. of copper.

CHINO COPPER COMPANY

The annual report of the Chino Copper Co. for the year ended December 31, 1916, shows the following: The gross production in concentrate and direct shipments of ore was 75,761,978 lb. Smelter deductions made the net production 72,319,508 lb. The gold and silver production realized from the smelter was $80,498.22. The amount of ore handled was 3,094,400 tons. The net cost of producing copper was 8.706c. per lb. after deducting miscellaneous earnings for the year from the cost of producing copper. This deduction amounted to 0.45c. per lb. The net operating profit was $12,517,876.18. Miscellaneous income, dividends, rentals, etc., amounted to $325,285.55, making a total net profit of $12,843,161.73, or $14.76 per share. Dividends paid during the year aggregated $8.25 per share, being a total of $7,177,335. A re-calculation of ore reserves at the end

of 1916 was 95,555,843 tons, containing an average of 1.656% copper. Of this quantity 94,490,936 tons averaging 1.655% copper remained unmined. The remainder, amounting to 1,064,907 tons, consists of mixed sulphide and carbonate ore stored in stock-piles, and contains an average of 1.81% copper. The total amount of ore and waste removed by steam-shovels during the year was 5,300,891 cu. yd. of which 3,216,065 tons was ore. Of this ore 646 tons was shipped direct to the smelter. The average cost of steam-shovel operations in removing ore and stripping waste was 37.97c. per ton. The cost of mining ore was 19.88c. per ton, an increase of 2.1% over the previous year, due principally to increased cost of labor and supplies.

CALUMET & HECLA MINING COMPANY

The annual report of the Calumet & Hecla Mining Co. for the year ended December 31, 1916, shows the mine to have had one of the most satisfactory of its many years of activity. During the year 3,166,274 tons of rock was treated at a mining cost of $2.03 per ton. From this was produced 71,349,591 lb. of copper, the average content being 22.53 lb. of copper per ton of ore. The total cost of production of copper was 11.63c. per lb. and the average price received for the metal was 25.48 cents. The price varied from 22.5 to 35.5c. per lb. Four dividends were paid during the year: $15 per share on March 23, $15 on June 24, $20 on September 22, and $25 on December 20.

During the year the necessary connections were made between the Calumet & Hecla and the Tamarack-Osceola systems. It has been decided to add 10,000 kw. to the power equipment, which will then have a total of 22,500 kw. All of the stamps ran throughout the year, practically without interruption.

The leaching-plant was put in operation in July and the result was so satisfactory that it has been decided to enlarge this branch of the equipment to a total capacity of 4000 tons daily. The reclamation-plant ran continuously in spite of the severe winter. With a temperature below zero for the greater part of 10 weeks and with 18 in. of ice on Torch lake, the dredge was kept going without loss of time. This plant treated 727,459 tons of tailing, producing 6,995,451 lb. of copper, the cost of which, exclusive of smelting and selling charges, was 4.39 cents.

MIAMI COPPER COMPANY

The annual report of the Miami Copper Co. for the year ended December 31, 1916, showed the following:

The net production of copper during the year was 53,518,331 lb. from the treatment of 1,842,017 tons of ore. The recovery in the concentrator was 73.88% of the total copper in the ore, of which 95% was returned in merchantable form, the difference being accounted for in smelting and refining losses. Improvements have been made in the concentrator that will augment the saving. Churn-drilling and underground work increased the ore reserves so that on January 1, 1917, the reserves were estimated as follows:

Sulphide ore, 2.4% copper, 16,400,000 tons; sulphide ore, 1.06% copper, 28,000,000 tons; mixed sulphide and oxide ore, 2%, 6,000,000 tons.

In order to put the property on a 6000-ton a day basis with a high concentrator recovery, additional power will be required and the power-house will be enlarged by the installation of two 610-hp. boilers and two 4000-kw. turbo-generators.

The cost per ton was $1.937, divided as follows: Mining, $1.1188; milling, $0.5891; general expense, $0.2294.

RAY CONSOLIDATED COPPER COMPANY

The annual report of the Ray Consolidated Copper Co. for the year ended December 31, 1916, shows the following: A recalculation of ore reserves in the property gives an estimate of 93,373,226 tons, containing an average of 2.03% copper. The net copper production for the year was 74,983,540 lb. The cost of production was 10.267c. per lb. of copper, this high cost being largely due to increase in the wages paid, this being based on a sliding-scale. The net profit for the year available for dividends amounted to $12,084,165.77, or $7.66 per share. Of this amount $4,337,954.75—$2.75 per share—was distributed in dividends. The total amount of ore mined from all sources, and shipped to the reduction works at Hayden was 3,363,466 tons, an average of 9190 tons per day, containing 1.63% copper. The mining cost was 80.073c. per ton, of which 5.146c. per ton was due to coarse-crushing and loading, leaving the net mining cost 74.927c. per ton.

PORTLAND GOLD MINING COMPANY

The 23rd annual report of the Portland Gold Mining Co. of Cripple Creek, Colorado, for the year 1916 is as follows:

Gross value of ore mined and shipped	$2,236,842.46
Gross value recovered by mills at Victor	612,576.89
	$2,849,419.35
Net cost of mining and milling	2,102,715.92
Gross profit	$746,703.43
Revenue from other sources	22,106.41
Total net profit	$768,809.84

During the year there were mined and shipped or treated at the Victor mills, 96,045.513 tons of ore. Sinking, driving, crosscutting, and raising totaled 18,263 ft. The total work done in the property to date is 310,850 ft. The total for the Portland mine is 58 miles, 4610 ft.; for the Independence mine, 16 miles, 1111 feet.

ALLOUEZ MINING COMPANY

The annual report of the Allouez Mining Co. for the year ended December 31, 1916, is as follows: Copper produced, 10,219,290 lb., sold at an average price of 25.305c., realizing $2,586,011.13. Silver sales, and miscellaneous receipts, $47,668.20, making a total of $2,633,679.33. Running expenses at the mine were $901,041.83. Expended on construction account, $22,321.35. Freight, smelting, commission, and Eastern office, $185,805.37. Total expense, $1,109,168.55, leaving a net operating profit of $1,524,510.78. Four dividends were declared during the year, aggregating $900,000. During the year 566,960 tons of rock was treated, at a cost of $1.589 per ton, including mining, transportation, stamping, and taxes.

LA SALLE COPPER COMPANY

The annual report of the La Salle Copper Co. for the year ended December 31, 1916, shows the following: Copper produced, 1,380,352 lb., which was sold at 25.68c. per lb., returning $354,409.23. Sales of silver amounted to $13,843.80, making total receipts from operation, of $368,253.03. Running expenses of the mine were $259,540.47. Construction cost $163.86. Smelting, freight, commission, and Eastern office expense was $29,306.82. Balance of interest charge, $386.79, making a total expense of $289,397.94. There was treated 144,829 tons of rock. Cost of mining, transportation, stamping, and taxes was $1.79 per ton of rock.

SUPERIOR COPPER COMPANY

The annual report of the Superior Copper Co. for the year ended December 31, 1916, gives the following: Rock treated, 185,315 tons; copper produced, 3,034,656 lb., which was sold at 24.67c. per lb., for $748,732.40. Sales of silver and interest, $26,732.72. Total receipts, $775.465.12. Running expenses at the mine, $382,982.16. Smelting, freight, commission, and Eastern office, $60,549.89. Total expense, $443,532.05, leaving a net balance of profit of $331,933.07. A dividend, No. 1, of $1 per share was paid October 10, amounting to $100,000.

Mining Decisions

MINING CLAIM—RIGHTS-OF-WAY OVER

Where the locator of a mining claim conveys all his right, title, and interest in a strip thereof to a railroad company, over which the line of road is constructed, the area so conveyed should be excluded from application for patent for the claim.

Frank Eyrand (Land Department), 45 Land Decisions, 212. July 10, 1916.

PLACER LOCATION—LEGAL SUBDIVISIONS

The smallest legal subdivisions authorized by statute in which placer claims on survey lands may be located and described are ten-acre tracts, normally in square form; but where location of a claim by ten-acre tracts in square form would necessitate the inclusion of lands which have passed out of the public domain or which are embraced in adjoining mining claims, the claim may be located and described by rectangular ten-acre tracts, even though not in square form.

William J. Harris (Land Department), 45 Land Decisions, 174. May 31, 1916.

ADVERSE CLAIM—EFFECT OF SUIT

A senior applicant for a mineral patent does not by the filing of an adverse claim against a conflicting junior application, and the institution of suit thereon, abandon or forfeit any rights under his senior application; and the pendency of such adverse suit does not operate as a stay of proceedings in the Land Department on the junior application pending determination of the suit.

International Asbestos Mills & Power Co. et al. (Land Department), 45 Land Decisions, 158. May 25, 1916.

EXTRA-LATERAL RIGHTS—'LODE' AND APEX DEFINED

A finding by the Court that "lenses or ore-shoots * * * have an easterly and westerly course reaching to or near the surface within the Granite lode and * * * come to the surface near the 4400 contour in a course slightly north of east to a stope which comes to the surface near elevation 4475," and again that the "orebody or ore-shoot which follows the bedding-planes, extends easterly and is disclosed on the surface at top of raise at elevation 4487" and that is again disclosed "at the top of raise 4587," amounts to a finding of an apex within the surface boundaries of the Granite claim. The orebody was found to have a definite "strike" and "dip," although it terminated on the strike against a wall of monzonite within the claim, and the dip was less than 45 degrees.

A lode containing lenses or lenticular bodies of ore or ore-shoots embodied in tilted beds of sedimentary strata might be classed by a geologist as a "bed" and not a "lode," but the law does not make distinctions based upon genetic principles. "A vein or lode comes within the meaning of the law so long as there is a fissure, seam, or gouge or any evidence of mineralization which will lead the practical miner from one orebody to another and which does in the course of his work so lead him."

The course of a vein where it is a crooked one is not determined by its direction at a single point, but by the course of the entire apex. The fact that it twists on its downward course into different courses does not affect this principle. The boundaries of the extra-lateral rights will be determined by the course of the apex, even though that course be nearly vertical at the point where the vein terminates against the monzonite wall.

Alameda Mining Co. *v.* Success Mining Co. (Idaho), 161 Pacific, 862. December 29, 1916.

Recent Publications

The following separates of Mineral Resources of the United States have been received:

ANTIMONY, ARSENIC, BISMUTH, SELENIUM, AND TELLURIUM, FOR 1915.

I-14, GOLD, SILVER, COPPER, LEAD, AND ZINC IN NEW MEXICO AND TEXAS IN 1915. By Charles W. Henderson; I-15, same in Utah, by V. C. Heikes; I-16, same in Colorado, by Charles W. Henderson; I-17, same in Arizona, by V. C. Heikes; I-18, same in Idaho and Washington, by C. N. Gerry; I-19, same in Montana, by V. C. Heikes; I-20, same in Nevada, by V. C. Heikes.

MAGNESITE IN 1915. By Charles G. Yale.

CLAY-WORKING INDUSTRIES AND BUILDING OPERATIONS IN THE LARGER CITIES IN 1915. By Jefferson Middleton.

GEMS AND PRECIOUS STONES IN 1915. By Waldemar T. Schaller.

COPPER IN 1915. By B. S. Butler.

METALS AND ORES IN 1914 AND 1915. By J. P. Dunlop.

MAGNESIUM IN 1915. By Frank L. Hess.

COBALT, MOLYBDENUM, TIN, TITANIUM, TUNGSTEN, RADIUM, URANIUM, AND VANADIUM IN 1915. By Frank L. Hess.

ARTIFICIAL GAS AND BY-PRODUCTS IN 1915. By C. E. Lesher.

STONE IN 1915. By G. F. Laughlin.

PEAT IN 1915. By James S. Turp.

BORAX IN 1915. By Charles G. Yale.

NICKEL IN 1915. By Frank L. Hess.

COKE IN 1915. By C. E. Lesher.

COAL IN 1915. By C. E. Lesher.

NATURAL GAS IN 1915. By John D. Northrup.

The following reports have been received from the United States Geological Survey:

PROFILE SURVEYS ALONG HENRYS FORK, UTAH. Water Supply Paper No. 420. By W. H. Herron. Pp. 8, with numerous maps.

PROFILE SURVEYS IN 1915 ALONG THE RIO GRANDE, PECOS RIVER, AND MORA RIVER, NEW MEXICO. Water Supply Paper No. 421. W. H. Herron. Pp. 11, with numerous maps.

USEFUL MINERALS OF THE UNITED STATES. Bulletin No. 624. Compiled by F. C. Schrader, Ralph W. Stone, and Samuel Sanford. Pp. 412. Alphabetically arranged. This is a revision of Bulletin 585.

GROUND WATER FOR IRRIGATION IN THE MORGAN HILL AREA, CALIFORNIA. Water Supply Paper No. 400-E. By W. O. Clark. Pp. 108, with maps.

PLACER DEPOSITS OF THE MANHATTAN DISTRICT, NEVADA. By Henry G. Ferguson. Bulletin 640-J, being a part of Contributions to Economic Geology, 1916. Part I. Pp. 30, with maps.

THE GARRISON AND PHILLIPSBURG PHOSPHATE FIELDS, MONTANA. By J. T. Pardee. Bulletin 640-K, being a part of Contributions to Economic Geology in 1916. Part I. Pp. 23, with maps.

TUNGSTEN DEPOSITS OF NORTHWESTERN INYO COUNTY, CALIFORNIA. By Adolph Knopf. Bulletin 640-L, being a part of Contributions to Economic Geology in 1916. Part I. Pp. 20.

THE CLEVELAND GAS FIELD, CUYAHOGA COUNTY, OHIO. By G. Sherburne Rogers. Bulletin 661-A, being a part of Contributions to Economic Geology in 1917. Pp. 18. Illustrated.

ANTICLINES IN CENTRAL WYOMING. By C. J. Hares. Bulletin No. 641-I, being a part of Contributions to Economic Geology in 1916. Part II. Pp. 46. Ill. with figures and maps.

CONTRIBUTIONS TO THE GEOLOGY AND PALEONTOLOGY OF SAN JUAN COUNTY, NEW MEXICO, (2) VERTEBRATE FAUNAS OF THE OJO ALAMO, KIRTLAND, AND FRUITLAND FORMATIONS. By Charles W. Gilmore. P. 29. Ill. (3) NON-MARINE CRETACEOUS INVERTEBRATES OF THE SAN JUAN BASIN. By T. W. Stanton. (4) FLORA OF THE FRUITLAND AND KIRTLAND FORMATIONS. By F. H. Knowlton. Pp. 26. Illustrated.

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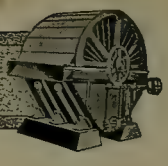

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E. H. LESLIE
600 Fisher Bldg., Chicago
A. S. BREAKEY
1760 Woolworth Bldg., New York

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EDITORIAL

T. A. RICKARD, Editor

KIRKLAND LAKE is a gold-mining district of relatively recent date. It is one of Ontario's new discoveries and promises to be a worthy neighbor to Porcupine. We are glad to publish an authoritative article on the district by Mr. G. C. Bateman, manager for the La Rose Mines at Cobalt and Porcupine.

CABLEGRAMS are now subject to censorship. This does not prevent the use of certain well known commercial codes, such as the "A.B.C.", Scott's, Western Union, Lieber's, Bentley's, Broomhall's Imperial Combination, Riverside, and "A.Z." Plain-language messages may be written in English, French, or Spanish, subject to a few exceptions. We are at a loss to understand the specific exclusion of mining codes in the orders for regulating cable-correspondence.

METALLURGIC progress has been so rapid in recent years as to make the general review by Professor Francis A. Thomson, published on another page of this issue, particularly valuable. The more revolutionary changes have revolved around the wide extension of the flotation process to ores of copper, lead, and zinc. As a result the reverberatory furnace is superseding the blast-furnace in copper-smelting, and the rapid development of electrolytic zinc reduction has become necessary. That in turn offers a field for the treatment of complex sulphide ores, once more robbing the blast-furnace, and lending color to the statement, now often heard, that the pyro-metallurgy of copper is obsolescent.

CARRANZA by a decree dated April 5 has transferred control of mines and mining concessions from the Department of Fomento to the newly created Department of Industry and Commerce. Included in the same portfolio are affairs connected with petroleum and fuels, and concessions for their exploitation, beneficiation, and transport. Considering the socialistic nature of the constitution under which the new government has been organized in Mexico, it is fortunate that the same ministry has cognizance of trade-unions and of matters in dispute between labor and capital. Vexatious delays in the adjustment of difficulties may be avoided by having to deal with but a single department in all that concerns the government's relations to the mineral industry.

PATRIOTIC service is in the mind of every good citizen. Many members of the mining profession already have obtained commissions in the Army and others have made application. Therefore any first-hand information concerning the realities of warfare in Europe is sure to be interesting at this time. We are glad to publish an interview with a mining engineer that has served with the British field artillery. Mr. Morton Webber is known to most of our readers by reason of his writings on the subject of mine valuation. He left his office at New York to serve his native country at the beginning of the War, as stated in the interview. We may add that becoming a 'casualty' a second time, in Bulgaria, he had to accept the official decision of unfitness for further service and return to the practice of his profession. Here we venture to suggest that such men, invalided from the front, ought to be valuable in giving instruction or advice to the volunteer officers now in training for taking part in the War.

REFINING of tin at the Perth Amboy plant of the American Smelting & Refining Company was mentioned in our issue of April 7. The wisdom of reducing tin in the country that is the largest consumer of the metal has become so clear that the Williams Harvey Corporation, an off-shoot of Williams, Harvey & Company, Ltd., of Cornwall, the most important firm of tin smelters in the world, has recently acquired a site at Mill Basin, Jamaica Bay, Long Island, where works will be erected immediately. The development of tin smelting as a permanent industry in the United States thus seems assured, and it must be credited as a direct result of the changes in trade relations brought about by the Panama Canal. When Bolivian tin concentrate had to be transported by way of the Straits of Magellan it was logical to take this product to Europe for treatment at the old-established refineries. It would be equally illogical to carry it through the Canal and almost within hailing distance of New York only to pay freight on the ingot back from England to America. The American Smelting & Refining Company gave the first demonstration of the commercial opportunity presented in applying this simple principle of conservation, and their competitors have acknowledged the point in a practical manner.

LAST week we reproduced some remarks made by Mr. Toyokichi Iyenaga at a public meeting at Philadelphia, suggesting that the peaceful relations of this country with Japan did not stand upon a secure footing. Apropos of that it is proper to take more than passing notice of the announcements just issued to the Japanese residents in America requesting all males between the ages of 17 and 45 to report to a person named therein, with the object of organizing a fully equipped army division "to fight for the United States." It is stated by Mr.

M. G. Yuasa and Mr. H. J. Wolff, who are active in the organization of the Japanese legion, that about 45,000 of the 80,000 men of that race in the United States are of suitable age, and have had military training. It will be recalled that the Allies declined the active co-operation of Japanese soldiers in Europe, and we also might correctly intimate that the organization of a Japanese army at this time is quite unnecessary. Assuredly the argument will hold with greater justification as applied to aliens, no matter how desirous they may be to fight for America, than it did against Colonel Roosevelt's proposal to raise a division of citizen-volunteers. If Japan choose to make a really serviceable proposal, indicative of the highest goodwill toward this country and toward her European allies, she might offer a portion of her rapidly growing merchant marine for the transmission of supplies from our ports to England and France in order to release an equal tonnage of American vessels for transporting troops to France and for maintaining them while there.

CHINA took a long look ahead when she elected to join our Allies; she was preparing to rend the ligaments with which Japan sought to bind her as a vassal. Very lucidly the situation has been explained by Mr. Hun Liang Huang in a recent address at Columbia University. China finds her grievance against the Central Powers in the paralysis of her European trade brought about by the submarine warfare. Taking advantage of this she secures a seat in the future peace council. Thereby she invokes the self-interest of the other powers, opposed to the aggressive exactions of Japan, in determining China's future status. Japan laid claim, by right of conquest, to the concessions and privileges that had been wrung from China by the Germans at the time of the original seizure of Kiao-chau. By offering her aid to the Entente, China obtains the assurance of material economic advantages. Revision of the tariff is conceded, liberating her from the arbitrary schedules imposed 17 years ago by the concert of European nations. Thus China will be able to collect *ad valorem* duties upon the actual market prices of articles of commerce, and in consequence her revenues will become adequate for the needs of a developing nation. This alone will be worth more to her than the costs and sacrifices she might be called upon to make as a result of participation in the War. The Chinese government has no expectation of contributing a contingent of troops, but it is interesting to note her proposal to furnish as many millions of laborers as may be needed, releasing an equal number of Europeans trained for effective military service. Rightly does Mr. Huang refer to this available army of workers as "an inexhaustible supply of human power." In addition it must be recalled that China is exceedingly rich in mineral resources, and can supply the Allies with arms and munitions more cheaply than Japan; indeed, the Japanese have depended mainly on China for the raw materials out of which were manufactured the supplies they have been furnishing to Russia.

Sulphuric Acid for Alkali Land

It is pleasing to record that the old feud between agriculture and smelting may be mitigated, if not actually set at rest, by an unexpected demand from the farmer for sulphuric acid in its normal vitriolic condition, unmodified by conversion into super-phosphate. Smoke-farming has long been a recognized industry, though a discreditable one. Smelters have retreated into secluded valleys and have occupied desolate alkali wastes to avoid doing injury to legitimate agriculture, but blackmailers have followed and taken up lands where the smelter-smoke would necessarily injure such crops as they might be able to raise. The collection of damages became in effect the equivalent of a market for an assumed potential output from the land. Not one of the smelting industries of the West has been free from this harrassment. Millions of dollars have been expended in litigation, and more millions have been paid to farmers within the zones of smoke-damage as a sort of annual commutation of the estimated losses. The suit against the Anaconda Copper Mining Company for damage done by its Washoe smelter has become a historic event; at one time the very existence of the enterprise was threatened by an injunction, but so great an establishment, with its contributory mines, upon which more than 25,000 people depended for a living, could not be closed. The principle of preponderating benefits finally governed. A different result followed in other places. The Mountain Copper Company in Shasta county, California, was seriously hampered by having to close its smelter at Keswick, and to haul its ore to San Francisco bay for reduction, while the Bully Hill, a profitable property when the output could be smelted at the mine-opening, was not of such magnitude as to admit of pursuing the course adopted by the Mountain Copper. It has remained closed for years, a loss to its owners and to the country. Strenuous efforts to overcome the difficulties presented by the fume have resulted in no broadly practical solution. If the sulphurous gas be converted into acid the problem of disposing of this by-product assumes a more serious aspect than that of diffusing the smoke into the atmosphere from the tops of lofty chimneys. The consumption of superphosphate as a fertilizer has not yet become sufficiently large in the West to create a demand capable of absorbing an important amount of sulphuric acid. Even the high prices obtaining during the War, caused by the enormous increase in the output of explosives and in general chemical manufacturing, have not encouraged the development of an acid industry in Western mining regions, owing to the prohibitive cost of transportation. Even as a by-product from gases going to waste, and despite the payment of penalties in consequence, it is, nevertheless, not economically feasible to compete with Atlantic sea-board acid-plants that have at command raw materials from Louisiana, Texas, Spain, and Cuba.

The Middle-West zinc smelters, situated in the heart of rich farming areas, have been forced into the manu-

facture of acid, and they actually produce an important proportion of the present output of the country. The growth of agriculture in the West threatens to aggravate the difficulties of the copper and lead smelters unless a new outlet for acid be found. Therefore it is a matter of extraordinary interest to know that investigations by the Agricultural Experiment Station of the University of California have shown that remarkably advantageous results are derived from applying undiluted 66° Baumé sulphuric acid to alkali soils. The tests on small plots have been in progress for three seasons, with no discordant results, and with increasing promise of establishing the method as one that may find wide application throughout the semi-arid West. For the metallurgist the significant feature is the fact that the treatment requires from one to three tons of acid per acre and the area to which the method is likely to be suitable aggregates many millions of acres. It is said that a half-millon acres in the San Joaquin valley in California alone would be benefited by it. These areas, moreover, happen to be coincident with the localities in which the principal Western smelters are situated. This is a fortunate combination, since the shortness of the haul from the centres of potential cheap-acid manufacture to the points where the acid is needed will greatly facilitate its use on a large scale.

Gypsum has been employed to neutralize the so-called 'black alkali' where an excess of sodium carbonate is present in the soil. The breaking up of the gypsum, however, is slow, and the effects are neither so prompt nor so thorough as those obtained by the direct use of sulphuric acid. The conversion of the sodium carbonate into sulphate is only a part of the benefit derived from the treatment. The physical condition of the soil is improved through the shrinkage of colloids. Furthermore the acid acts upon the chlorides, giving a double advantage. It has been shown in experiments conducted by the Division of Soil Chemistry of the College of Agriculture that when a large amount of sodium chloride has been leached away by irrigation the excess of resulting colloid leaves the soil impermeable to an extreme degree. Moreover, the sulphates formed are less toxic to plant-life than the chlorides originally present. The destruction of chlorides by sulphuric acid, in conjunction with its pronounced action as a flocculating agent, gives a wider field of use than that of merely neutralizing alkaline carbonates. It is said that when applying the acid from a sprinkling-cart the workmen are obliged to wear gas-masks as a protection against the chlorine evolved. The carbonization of organic matter in the soil, resulting from the application of sulphuric acid, would probably promote favorable conditions for the development of the bacteria that are useful in plant-growth. It is the expectation of those having the experiments in charge that one treatment by acid may in some cases prove a permanent corrective of the alkalinity of the soil; in other cases re-treatment at intervals may be required, since carbonates will be renewed, as well as brought to the surface by capillarity and concentrated there by evaporation. In any event, considering that the total output of sulphuric acid in the United States in 1916 was 5,500,000 tons, and in 1914 was only 3,162,439 tons, a new use that may demand some millions of tons within the next few years is a matter of the highest importance to the Western smelters. The experiments will be watched with eager interest. So happy an alleviation of the fume-difficulty, in which the farmer and the smelter can join hands in mutual helpfulness, is something that had not been anticipated. It was a bold conception to use a strong mineral acid for the improvement of soils, but it proves to be based on sound chemical, physical, and biological reasoning. Lands previously encrusted with alkali, and quite unproductive, have been made to yield nearly two tons of barley-hay per acre following a single treatment by sulphuric acid. The method manifestly may be expected to create a market for acid having far greater possibilities in agriculture than the utilization of other forms of so-called smelter-waste.

Commercial Patriotism

Abnormality has put reason out of court in the metal market. The law of supply and demand has met an unforeseen contingency. Military necessity must decide prices in the immediate future, and no man can tell how far the restrictions of the Government may extend to the private transactions of commerce. The trend of prices for copper and lead is moderately but distinctly downward. It must be noted, however, that the price of copper is fixed by Mr. John D. Ryan and the Messrs. Guggenheim, and that of lead by the Messrs. Guggenheim alone. Only those who happen to be in the close confidence of these gentlemen are capable of reading any such significance into the price movements of the moment as will serve to interpret the future. Already it is evident that the offer of a limited quantity of copper to the Government at the average price of the past ten years lacks the merit of sustained patriotism. The complement to that splendid offer, made at a time when it warmed every American heart with responsive gratitude toward those volunteering pecuniary sacrifice for the country, would have been a continuing arrangement for lessening the financial burdens of preparation for the overthrow of the common enemy. It is not facing the facts of the War to discriminate between the United States and the Entente Allies in the existing crisis. It took our people long to recognize the truth that the Allies were fighting our battles, that their success meant our safety, their failure our undoing. The last lingering doubt of this in any mind must have been shattered by the recent revelations of Mr. James W. Gerard, who speaks with an authority that cannot be challenged. He tells us, from the vantage-point of an ambassador to the court of the Hohenzollerns, that Germany counted upon crushing England by means of submarine warfare, and then falling upon us in our state of impotent unpreparedness before we might have time to buckle on our armor. All this has much to do with metal prices. It means that the

selling of 45,000,000 pounds of copper at 16.6739 cents per pound is admirable only as a beginning of a patriotic sacrifice. Even to sell to the Government all that it may need for the next two years at that price is not meeting the necessities of the situation. It is not the Government that wages war; it is not the Government that overcomes a national foe; it is the people, co-ordinated for effective effort through the administrative organization. It is strange that a preachment, emphasizing primary fundamentals that should have been learned in the Montessori infant-school, should now be necessary, but it is clear that the public is confused between the guesses of speculators in the market and the mysterious movements of those who direct the market from behind. It is not with the product of the Government shops only that this war will be won, but with these plus the output of every factory in America, in England, and in France; it is on all of these together that the freedom of Mr. Ryan and of every metal-producer to continue his business depends in the future. When one of the controllers of copper production declares that "it would be unfair to consumers at home if European buyers [meaning the Allies] were allowed to take supplies at lower prices than they [our domestic buyers] were charged," it is time to call things by unpoetic names; it is time that we as patriotic Americans should call upon our sense of humor in explaining the industrial harvest we have reaped at the expense of struggling peoples across the Atlantic, and atone for it by taking at most a modest profit for such necessaries of warfare as we shall provide. The principle involved is broader than national patriotism, and as such it must be understood and accepted. The producers of copper would be doing a greater service by facilitating the regulation of the prices of all commodities by a war commission, established for that purpose, than by creating sentiment against so sane a procedure. They do not show the right spirit in stating that, if metals are to be controlled, so should flour and butter and eggs, and then throwing out the sordid suggestion that, if such a propaganda were set on foot, "there would be so great a clamor that the project would be quickly dropped." As a matter of fact precisely such thorough-going administrative regulation of prices is provided for in the Lever bill just introduced into the House. On the other hand we are not prepared to adopt fully the reasoning of a correspondent, Mr. William E. L. Dillaway, in our issue of April 21, who sees in the generosity of the copper producers only a "thimble-rigging of mining companies by people who are willing to snuff the battle afar off provided they can short the stock-market." The opportunity for manipulation is there, coupled with the existence of a gullible public, but it is unfair to single out the copper producers for criticism; they are not alone in failing to recognize that the maintenance of high prices, even with reference to the un-preferred customers, combined with a straining of government credits both here and abroad, is the same thing in effect as forcing gold to a premium with its attendant evils of depreciated currency-value and financial disaster. In the phrase of the day, the purchasing power of gold has declined, but it is all the same thing, and the baneful results are not modified by reading it backward or forward.

Until the great captains of the iron and steel industry see the light, and help to protect themselves and the country by sounding the note of alarm and by calling for co-operation in wise regulation of selling-prices and wages paid, we must withhold special censure of the masters of other metals. The aggravation of the situation through the attitude of the steel producers seems to us even more reprehensible. They likewise have posed as magnanimous patriots. They have won encomium, many of them, by submitting to what the public has been coached to believe is a kind of economic self-effacement in taking unlimited orders from the Government at actual cost of production plus a 'nominal' profit of 10%. In short, they are ready to deal with the most responsible of all customers on a guarantee of 10% upon cost of raw material, labor, depreciation, renewals, insurance, and all the rest. What safer deliverance from the ordinary vicissitudes of commerce could enter the dreams of the most optimistic manufacturer? Moreover, how is the Government protected against soaring prices by this arrangement? Sensational advances have taken place in bessemer, basic, foundry, and other grades of pig-iron. A year ago bessemer was selling around $21 per ton; today it is quoted at $43. Within the same period Connellsville furnace-coke has risen from $2.65 to $8 per ton. This is a measure of the general advance, and points the whole moral. So far-reaching are the co-ordinate industries affecting the ultimate cost-factor in the articles of common need, upon which hangs the strength and efficacy of our national defence, that the one sane way is to eliminate the whole wretched business of market speculation during our period of stress. One commodity cannot be boosted without shifting the centre of gravity of national industry. The inter-relations of commercial activities are such that they constitute an organic unit. The high price of steel-sheet means a more costly potato; it means increased financial suffering on the part of those who make the sacrifice of sending their loved protectors to the front; it casts the shadow of home-distress upon the soldier whose duty it is to fight for flag and country; the sense of the injustice of it chafes his spirit and can but affect his valor. He who counsels and supports high prices at this time comes very near to offering sacrifice to Moloch. To quote one price to the United States and another to our companions in arms, and then to charge the private buyer the higher price whereby that price directly or indirectly gets figured at last into the costs against the Government in other industries, not only savors of the ancient religiosity of robbing Peter to pay Paul, but injects the principle of the trade-war into the relations between the very nations now fighting, as we hope, for the abolition of this most fertile cause of international conflict. The sooner we all agree to protect ourselves and those with whom we are now linked in the universal struggle for civic and industrial freedom by rational price-regulation, the finer will be our service to the world and the richer our experience of active patriotism.

A Mining Engineer's Experience in the Artillery

AN INTERVIEW WITH MORTON WEBBER, BY T. A. RICKARD

Mr. Webber, you have seen service at the front recently, have you not?

My last active service was in December 1915, and I was finally invalided in May 1916.

Mr. Webber, will you say something about your experiences as an artillery officer in the War?

I dislike this sort of thing, for obvious reasons, and I have refused numerous requests to put my experience into print.

That is natural; but things are different now that America is in the War. There must be many mining engineers, eager to follow in your footsteps, that would like to hear about your experiences.

Yes, I have thought of that, and I shall be glad, in a small way, to help the good work along.

On what fronts have you fought?

In Flanders, in the Gallipoli peninsula, and in Bulgaria.

When did you join?

I left New York, where I was in practice as a mining engineer, in November 1914, proceeding to London with the intention of obtaining a commission in a Scotch regiment, as I had several relatives in Scotch regiments, including the honorary colonel of the Argyll and Sutherland Highlanders, but, as you will recall, I had a talk with you on my arrival in London, and you urged me to join the Field Artillery. Your letter of introduction enabled me to obtain a commission in December 1914. I was sent to the reserve depot near Exeter, in Devonshire, and underwent training as an artillery officer for two months before being sent to Flanders to replace a casualty.

To what part of the line did you go?

To the Ypres salient, where my battery was engaged in the fighting at Hill 60. After being there four weeks, I was wounded in the leg by a shrapnel bullet, and invalided to England.

Will you say something about your experience at Ypres, stating such facts as would interest your friends in the mining profession?

There is nothing technical I could say except that I was there at the very worst time, when we were quite inadequately equipped, having few high-explosive shells with which to demolish German trenches and emplacements.

Then shrapnel is no good against a gun-emplacement?

Not unless you can register a direct hit, which is seldom done; for example, suppose a German battery was firing at our emplacements with high-explosive shells that burst within 30 yards of us, the result was generally effective, whereas if we engaged them with shrapnel in reply—as we had to do—we had either to register a direct hit on their emplacements or we merely peppered the emplacements with shrapnel, which did little damage.

What do you mean by an emplacement?

The emplacement may be an earthwork around a gun or it may be a structure built of concrete, sand-bags, or even steel plates.

Did you find your experience as a mining engineer of any use to you?

I found my training as a mining engineer of the greatest value, because practically all modern artillery engagements depend upon what is known as 'indirect' fire, which is a process of triangulation. The average civilian who attempts to become an artillery officer has to start from the ground up. It was because I had received this knowledge that I was sent to France within two months; the ordinary training takes about six months. In short, I found little difficulty in applying range-finding methods. Furthermore, of course, my experience as a mining engineer made me familiar with the nature of explosives and particularly the directing of men; also it may be of interest to state that in our brigade there was a large proportion of Welsh colliers, whom I understood much better than my fellow-officers. I was a section-commander, so I soon had a number of sturdy Welsh coal-miners under my command.

In regard to horses, had you been accustomed to them?

Yes, I had been accustomed to horses most of my life, not only as regards the use of them for draft, but I had done a good deal of steeple-chasing and riding to hounds when a boy in Devonshire.

Did you lose many horses in the course of your campaigns.

I lost eight altogether, all of which, except one, were shot. Fortunately they were shot when I was not riding them, except one, and he rolled on me so that I was laid up for about three weeks in a field-hospital.

On returning from Flanders, how long were you in England?

I was in hospital about nine weeks, and then I was sent in command of a detachment of about 100 gunners to Alexandria, where I was made section-commander in the artillery of another division.

Where were you stationed?

First at Aboukir, then my battery was loaned for the defense of the harbor at Alexandria.

How did it happen that a field battery was so employed?

Because the harbor fortifications had been built before the day of the submarine, more particularly prior to submarines being supplied with 4-in. quick-firing guns. It was discovered that it was possible for an enemy submarine to approach under water and to rise within the maximum depression of the guns of the fortifications and therefore to do enormous damage to the congested shipping in the harbor. My section was posted so as to command one leg of the breakwater and the other section of a battery was posted so that it could command the other leg.

I think you told me something about an experience with spies?

Oh yes; my section was posted close to the Raseltin Yacht Club, which is one of the fashionable clubs of Egypt; I was made an honorary member and went there for meals, so that I met a good many people, among others, a fashionable lady, who, under guise of patriotic hospitality, entertained me. I confess that I was curious as to her motives, and particularly skeptical of her sympathy. One day she asked me, as if by accident, where our observation-station was. This question from a woman indicated a knowledge of modern gunnery that was unusual, and I immediately became cautious. I debated in my mind whether I would shut up or play the part of a fool, and I decided that the latter would be the easier. So I told her that it was the steeple of the English church, which, of course, it was not. After that, we were interested to see if a German submarine would come and take a crack at the English church, but our torpedo-destroyer defense outside the harbor was too effective. Subsequently this lady dropped me, as she supposed she had the desired information, and started the same game with a remount officer, whom I took occasion to warn.

You did not stay in Egypt long?

No; after the coast-defense people erected quick-firing guns as permanent structures, my battery re-joined our brigade at Aboukir, and soon afterward—in June 1915—we were sent to the Gallipoli peninsula.

So you took part in the campaign there?

Yes, I was there until September. During those four months we had continuous fighting day and night; that is, we were shelled continuously by day and night. Our position was most precarious.

Will you kindly say something about your experience as an artillery officer at Gallipoli?

Our great difficulty was that owing to the topography we were unable effectively to shell the Turkish trenches, because they were, in many cases, on reverse slopes.

What is the effect of having a trench on the reverse slope?

A reverse-slope trench means that it is situated on the other side of the sky-line. It was impossible for us at such short range—say, up to 2000 yards—to get the angle of descent necessary to shell the enemy effectively. We could not put our guns farther back, in order to get the necessary angle of descent, because of the sea, whereas the Germans could withdraw their batteries to any convenient distance inland in order to get the proper angle of descent; so their fire was much more effective than ours. In this statement I am touching on what I believe to be one of the principal causes of our failure at Gallipoli. The enemy's artillery, as I say, shelled us day and night, which, especially during the hottest time of the year, was most trying. I may say that for four months I think that no person in the Expeditionary Force had three unbroken hours of sleep. All our guns had to be man-hauled during the dark, there being no place where we could get cover for our horses. This failure in effective shell-fire was what caused the enormous casualties that we had to suffer, inasmuch as when we attacked an enemy trench our infantry came up on the sky-line, exposing themselves to fire from Turkish trenches on the reverse slope that practically had been undisturbed, whereas we had to cease our shrapnel-fire at the very moment when it was most needed because we would inflict more casualties on our own men than on the enemy as illustrated by Fig. 1.

The Turkish batteries were commanded by Germans and Austrians?

Almost entirely.

What were your approximate casualties?

I cannot answer that question, as there are some things which you will understand I cannot go into, but I may say that in approximately ten square miles we lost half the total casualties in France in half that time.

This is appalling; what was the cause of it?

I have already endeavored to explain how ineffectual our artillery was because the topographic conditions were entirely in favor of the enemy; also, the enemy instituted a practice of destroying their traverses before abandoning their trenches. You will understand that a modern trench is never continuously straight; it is straight for a certain distance—say, 30 yards—and then it has a bend—of 5 yards radius—and is straight again to the next bend. These bends are called 'traverses.' This is done to prevent enfilading by machine-guns or other gun-fire; in other words, to restrict the effect of such fire to a short length of the trench. The Turks, when they had decided they had to give up a trench, dug through these traverses, as I have explained, and constructed machine-gun bulkheads at both ends. Our infantry then attacked the trench, captured it, and became exposed to such machine-gun fire. In this way entire regiments were decimated. (See Fig. 1 and 2).

Surely this was not done often?

It was very difficult to prevent, for the reason that I have already given, namely, our artillery could not demolish a trench before we took it. It was essentially a fight between machine-guns under cover and our men in the open. Of course, all this is past history, otherwise I would not be at liberty to tell you about it.

You yourself were not wounded at Gallipoli?

No; I was particularly lucky.

Why did you leave in September?

At that time General Sarrail made the original landing at Salonika, and as he was short of field-guns, our brigade was loaned to him, and with him we went on the original Balkan expedition.

How many guns are there in a battery?

There are four guns in a Field Artillery battery, about 150 horses, and 150 men.

I thought there used to be six guns.

That is so, but then there were only three batteries to a brigade and now there are four batteries to a brigade. This re-arrangement has many advantages, which I need not discuss.

So you became part of the first Anglo-French expeditionary force that invaded Bulgaria?

Yes, and here I may say that the misfortunes of the Gallipoli campaign were due in part to a breach of faith by the Greeks, for it was understood that they would land an army immediately our fleet began the bombardment at the Dardanelles. The Greeks not only failed to carry out their bargain, but they adopted an unfriendly attitude, called "benevolent neutrality." I was very much amused to observe that we landed at Salonika under the protection of at least ten of our own battleships, out in the harbor, so as to make the Greek neutrality as benevolent as possible. On our return from the expedition, which was driven back by an overwhelming force, the Greeks threatened to intern us if we returned as a fighting force, whereupon when we did re-return we arranged a formation called 'form starfish,' the object of which was to be able to fight on all sides.

So you had a hard time?

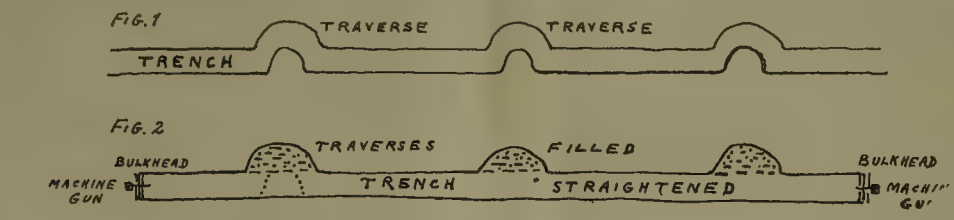
Yes. Our front was attacked by two Bulgarian army corps, making 160,000, while our force consisted of 15,000 only. I should explain that a Bulgarian army corps consists of 80,000 men as against the British army corps of 40,000.

How far did you penetrate into Bulgaria?

We drove the Bulgarians out of Serbia, across the Vardar river, into Bulgaria. Both belligerents finally took up winter positions in a mountainous country, very much like Colorado. My battery—

You had been promoted?

Yes; I had become captain. My battery was on top of a mountain where we had to man-haul our guns in the dark, and our horses were three miles in the rear in a valley where they could get water and cover.



DIAGRAMS SHOWING CONSTRUCTION OF TRENCHES

This must have put you to a great disadvantage?

Yes; because in event of a retreat, there was no way of getting our horses up to our guns, because the line of communication was completely 'registered' by enemy batteries. This was the farthest point we got; the Bulgars were able to mass in overwhelming force, as I have stated. They literally swamped us. It was necessary to sacrifice the guns to enable the infantry to retire; in other words, we had to hold our ground while the infantry withdrew, as against the usual method of withdrawing the guns by stages, prior to the infantry.

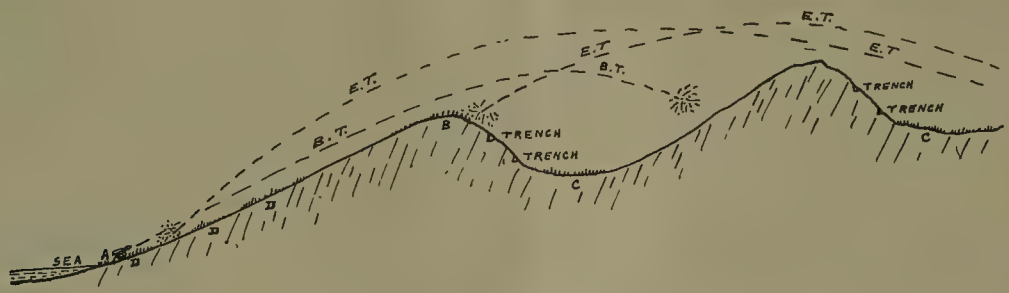


FIG. 3. A. BRITISH GUNS. B AND D. BRITISH. C. TURKS. ET. ENEMY TRAJECTORY. BT. BRITISH TRAJECTORY

What happened?

Two of my guns were knocked out by direct hits, and we man-hauled the other two guns down the mountain in the dark. In doing so, the spokes of one of the guns was so badly shot away that we lost that gun also; the fourth gun, however, we did save, and were able to haul away as soon as we got our horses. Out of my 150 men about 30 remained. I then had a most unwieldy force, namely, 1 gun, 30 men, and 150 horses.

What did you do?

That was the end of my battery, because my Colonel told me it was no use 'carrying on' in this way, so my

horses and my men were distributed over the remainder of the brigade, and I replaced a casualty in another battery. Then the remaining two batteries of our brigade took up rear-guard positions alternately on the Rabrovo Pass—in Serbia—to protect the retreat of the infantry. This was accomplished successfully, and we made the enemy more than pay his pound of flesh. I may add that this was the first time in my military experience that I was fighting with the odds about even. It had been a one-sided show in France, a more than one-sided show in Gallipoli, and even worse in Bulgaria. Through the hottest months of the year at Gallipoli my men fought stripped to the waist; then they were sent to the Balkan snows without tents.

How do you account for this pitiful affair?

For the very good reason that Great Britain was not prepared for war, and Lord Kitchener was forced to kite checks of human lives.

You mean that Kitchener had to organize expeditionary forces of a forlorn kind, for political purposes, during the first period of the War?

Exactly. We were asked by Russia to make a demonstration at the Dardanelles, although there was no reasonable expectation of success after the Greeks had failed to land an army at the time of the naval bombardment. We went there with the sole object of localizing the Turkish army; in the same way we went on the hopeless first Balkan expedition with the object of menacing the line of communication between Berlin and Constantinople. This may emphasize what I mean by Kitchener being forced through necessity to "kite checks of human lives." I think this is a point that you people in America have not appreciated.

So you were scuppered finally?

Yes, while defending the Rabrovo Pass, on December 6, a gun in my battery received a direct hit and a splinter of it struck me in the back inflicting a wound that involved serious complications.

Was your ambulance service well organized?

It was impossible to have any ambulance organization as we retreated 80 miles in 4½ days, fighting continuous rear-guard actions.

Wounded as you were, why were you not made a prisoner?

Because my groom, a fine fellow, got me on one of my own horses and kept me on it until I reached a base-hospital. I was kept on a hospital-ship at Salonika about three weeks before being removed to a hospital at Malta, where I remained for about six weeks, finally reaching England in March 1916. The authorities decided that I was unfit for further active service, whereupon I tried to get into the French artillery, but as I had no knowledge of French, they would not take me.

Could you say something about your method of reconnaissance? As I understand it, 'indirect' firing means that those at the guns of a battery do not see the target they are aiming at. Is that right?

Yes.

Then, how is it possible to know what you are hitting, and, first of all, to ascertain the exact position of the object of your aim?

Generally the target, while not visible to the battery, is observed from some elevated position on the flank, or possibly directly in the line of fire, such as a first-line trench. Firing is directed from this point by an observation officer, and it is in working out this triangulation that the principles of trigonometry are used. However, the enemy's base, including such objects of attack as an ammunition depot, can only be located by aviation.

So the artillery officer has to make an aeroplane reconnaissance?

Yes, and it may represent a very important part of his work.

Did you do any of it?

Certainly, I was chosen for this work often, because of my small weight, especially when we were working in co-operation with a heavy battery behind us. For example, three of us would go up in an aeroplane.

What three?

My pilot, myself, and the telephonist. Our duties were as follows: the pilot was in charge of the machine; he had to go where he was told, and used his best endeavor to avoid being brought down by the enemy; the observation officer works in conjunction with his telephonist and through him sends instructions to the battery with which he is co-operating, either by wireless or by flashes.

By a 'telephonist' is meant a telegrapher, I presume?

Yes, if you like.

How does he get a reply?

If the aeroplane is supplied with wireless apparatus, the observation officer sends his orders by this means, and receives acknowledgment, usually by heliograph, because the wireless apparatus on the aeroplane, on account of its lightness, is able to send but not receive messages. The idea is to switch one of your own heavy guns, by means of locating the 'bursts' of its shells, onto an enemy base, or to establish a new register on enemy arteries of supply, which thereafter can be shelled at irregular intervals. For instance, the first time that I went up, it was with the object of locating an enemy base behind a range of hills. We flew over this range at a height of about 10,000 ft. to keep out of the reach of rifle-bullets, and were able to locate what seemed to be the preparation of an ammunition depot and a mule-transport depot belonging to the Bulgars, and also a bridge over a gulch, which we were able later to destroy by means of gun-fire.

Did the enemy fire at you while you were in the air?

Yes, they did, but I was so absorbed in my work, looking through my field-glasses, that I did not know anything about it until after we came down, and I could see that there were holes in the wings of the plane. I need hardly say that when engaged in this sort of work the idea of danger hardly arises, as the observer is so busy

and the noise of the aeroplane-engine is so great that he cannot hear the bursting of shells near him.

What kind of glasses did you use?

Prismatic field-glasses, with a very large field of view. Here I might advise young officers to avoid buying a glass of more than six magnifications, because as the magnification is increased the field of view is diminished—a vital defect—and the strain on the eye is greatly increased.

Did you take turns in observation, or in what manner is the observation officer selected for this dangerous duty?

It depends upon a man's aptitude for such work. Again, in this branch of the service, the training of an engineer is of value, as he may be asked to make sketches of what he sees.

For a ground observation, how do you select officers.

As a general rule, each battery has its own observation officer, and the officers of a battery should perform this duty in turn, as it is very trying and decidedly the most dangerous work that an artillery officer is called upon to perform, because, of course, the enemy is always looking for observation stations, these being the eyes of the batteries. This work should be done in relays, otherwise the nervous system won't stand the strain.

Would you describe an example of such observation work on the ground as distinguished from your air reconnaissance?

When in command of my battery in Bulgaria, we used a house in a destroyed Bulgar village, on top of a mountain. I went there in the dark, with my servant and two telephonists, staying there until the following night, when I was relieved by an officer and his relay. From our point of vantage we could see all the Bulgar trenches, and were able to direct our fire.

Were you not exposed to sniping or shell-fire?

We were out of danger of rifle-fire, but as the Bulgarians could not hold this village, they made up their minds we should not have it, and they shelled the village every three hours. Of course, they did not know which house we were in, but, in true German style, they sent over about seven shells every three hours; in fact, we could tell what hour of night it was by the time they came through.

By the way, the phrase 'curtain of fire' appears in the daily press frequently. Would you kindly explain it?

Imagine a trench that we desire to take. A given brigade will attend to a section of trench, 300 to 500 yards long, and shell it within an area of that length by 100 yards deep. This imaginary rectangle runs lengthwise of the enemy trench, which is relatively near the nearer long side of the rectangle, in order that the splash of our shrapnel may just reach the enemy and compel him to remain under cover so that he cannot use his rifles on our infantry when they advance. Meanwhile the fire on the two short sides of the rectangle and on the back line of the rectangle prevents the enemy in this section of trench from receiving any reinforcement. This is called a 'curtain of fire,' although to a layman it may seem more like a quadrilateral. The observation officer, as he sees his infantry advancing to just short of the zone of dispersion of his own shrapnel-bullets, sends the order to his battery "add 100"; the battery thereupon advances its fire that much and makes a double line of exploding shells behind the enemy. Our men then go into the trench with their bayonets and bombs.

During this operation, how many shots per minute does a field-gun fire?

From 12 to 18 shots per minute, or a shot per second per battery.

How long can they maintain this before the gun becomes too hot?

I have never seen a field-gun become too hot, if you mean become hot enough to cause a premature explosion in the barrel. This kind of work is limited by the ability to bring shells to the guns, as the modern field-gun has outstripped any process of supplying ammunition. By the way, these curtains of fire are always made by field-guns, and by no other, so you can guess what an important part they play in the War.

You would recommend members of the mining profession to join the artillery?

Most decidedly, but if they are not familiar with horses they should not attempt to go into the field artillery, but should join the heavy artillery. By 'heavy' is meant anything bigger than the field-guns. All armies have a field-gun, which is drawn by horses and is supposed to gallop into action.

Of what calibre are these guns?

The British field-gun is of 3.2 inch calibre and fires an 18½-lb. projectile; the American field-gun fires a 15-lb. projectile, and the French 75-mm. gun fires approximately the same weight of projectile. I might recommend mining engineers that want to 'do their bit' to become identified with as heavy artillery as possible. By this I mean guns of more than 6-inch calibre.

Why is this?

Because such a gun may be in the same position for a month at a time, and it is possible for the officers to dig themselves in, erect structures for their accommodation, and become quite comfortable away from rifle-fire—the bête noire of the gunner. The 'heavies' have the easiest time of the whole fighting force, whereas a field-battery, especially in an engagement of moving forces, may have to take up four or five different positions during a single day, and one never knows where one is going to sleep next. Of course, what I said just now was intended to be humorous. I feel sure that our mining engineers will seek not the most comfortable but the most effective service in their power, but I do not recommend a mining engineer to join the Field Artillery unless he has a knowledge of horses and is a good horseman himself, otherwise he will be at a considerable disadvantage.

Five Years of Metallurgical Progress

By FRANCIS A. THOMSON

Five years is a brief period in the history of an art, yet it is doubtful whether any similar interval of time, even including those eventful days in the early nineties when cyanidation was making its triumphal entry, can show as many momentous metallurgical improvements as are to be credited to the five years preceding 1917. Exceeding all other metallurgical events in significance, actual or potential, stands the progress of froth flotation. Five years ago all were skeptical, and timidly inclined to place this along with hundreds of other moribund patent processes. This was a mistake. Today flotation ranks as the leading single process of ore treatment, no other method equalling it in tonnage handled. The amount of ore treated by the major processes in use in the United States is about as follows:

Treatment	Tons per annum
Flotation	30,000,000
Copper smelting	26,000,000
Gravity concentration	25,000,000
Gold and silver milling	13,000,000
Lead smelting	5,500,000
Copper leaching	2,000,000
Zinc smelting	1,000,000

About the same ratios apply to world production, except that the proportion treated by copper smelters will be less and by gold mills greater than here given. The annual capacity of the world's flotation plants is approximately 50,000,000 tons.

It is easier to enumerate the ores to which flotation is not adaptable than those to which it applies. Gold, silver, copper, lead, zinc, molybdenum, cinnabar, tungsten, and many more are being successfully handled, and it is proposed to use the process for the recovery of substances as far apart as flour-gold and anthracite coal. Truly, the process that the experts rejected has become the leading one in the art.

The influences exerted by the introduction of flotation are manifest in several ways: (1) by the simplifying of mill flow-sheets and increasing the extractions, as, for example, 82% is about the best extraction attainable by gravity concentration on average sulphide copper ore, while 96% may be recovered by flotation with a less complex plant and lower cost. (2) By making possible the beneficiation of ores hitherto not amenable to concentration, such as the sulphide silver ores of Mexico and the South-west. (3) By forcing vital changes in methods for the recovery of metals for concentration products. The latter is illustrated by the sudden extension of the use of the reverberatory furnace in copper smelting, since it is virtually impossible to treat the flour-like flotation-concentrate in a blast-furnace which has a gale of wind blowing through it. Another illustration is afforded by that of the treatment of flotation concentrates for zinc recovery in retort-furnaces, the effect of which is that of turning the scales in favor of electrolytic zinc. In lead smelting, the already established sinter-roasters have saved the day. Without them the lead metallurgist would have been overwhelmed by the volumes of film flotation-concentrate that has been coming his way. The success of flotation is understood to have changed the entire plans of the Anaconda Copper Mining Company. They abandoned their great leaching project for sulphide ores, in favor of the newer process.

That flotation has its limitations and that attempts have been and will be made to apply it to ores better suited to treatment by other processes, is natural, but at present we have not discovered its limitations. One scheme which looks doubtful on the face of it is the proposal to convert the copper in oxide ores back to a sulphide by chemical means and then to float the artificial sulphides. This savors of needless and unnecessary complication. It is, however, evident that flotation has not only come to stay, but that it will continue to grow in the matter of tonnage treated, stupendous as that present tonnage is.

Next in significance to flotation may be placed the electrolytic process for the recovery of zinc. All know the process. The zinc concentrate is roasted; then leached with sulphuric acid made from the roasting-furnace gases; the solution after purification is electrolyzed, and the zinc precipitated on aluminum cathode-sheets, stripped, and melted into ingots. Such zinc on account of its exceptional purity commands a premium of 1½ to 2c. per pound over spelter produced in the ordinary way by distillation in retort furnaces. In spite of protests by those engaged in retort-smelting, the process has proved successful and is destined to make zinc distillation look to its laurels, if in fact it does not eventually replace it entirely. Zinc smelting has long been criticized on the score of the initial high cost of plant, the high labor-cost in operation, and excessive consumption of fuel.

The extremely fine state of pulverization of the zinc-flotation concentrate has added another difficulty to the distillation process, such material tending to pack in the retorts, with the result that retort explosions frequently occur. This fine material, on the other hand, is well adapted for the electrolytic process. At Great Falls the Anaconda Copper Mining Co. has recently begun the production of electrolytic zinc from a plant which will soon have a capacity of more than 200 tons of metallic zinc daily. At Trail the Consolidated Mining & Smelting Co. is producing 75 tons of spelter by practically the same process. Numerous other plants are in construc-

tion, and in Tasmania a plant is being erected for the treatment of zinc ores from the Broken Hill Mines of Australia, the product of which, prior to the War, was the basis of the German and Belgian zinc industry. A great advantage possessed by the electrolytic process is its ability to treat lower-grade ores, and those that are more complex, than is possible by the fire-method. Western lead mines have long suffered from zinc penalties imposed on ores shipped to lead smelters. When electrolytic-zinc equipment becomes part of the necessary plant at a lead smelter, as at Trail, the presence of a high zinc-content in lead ore will mean a profit instead of a penalty. There are unsolved problems connected with the treatment of the melting-furnace dross and of the lixiviation residue. At Trail it goes to the lead furnaces. With non-lead ores the problem is not so simple. In any event the electrolytic production of zinc, following the leaching of roasted ore, is a distinct success. It may replace retort-treatment entirely, or it may not, but the retort smelters have to face a process already making appreciable inroads on their business.

In copper metallurgy, during the past five years, leaching has made rapid strides. Sulphuric-acid leaching of accumulated tailing is being applied at Anaconda, where 2000 tons per day is being handled. In Arizona the Ajo plant is just starting, where semi-oxidized copper ore is leached with 10% sulphuric acid in tanks 88 by 88 ft. and 15 ft. deep. Many other copper companies are supplementing their regular treatment of sulphide ore by lixiviation for the oxidized material. In several South American plants leaching is successfully employed, notably at Chuquicamata, where a 10,000-ton unit, the first of four, is in operation. The leaching is being conducted in concrete tanks 110 by 160 ft. and 16 ft. deep. At the Calumet & Hecla in Michigan, a 1000-ton plant is treating native copper ore by leaching with a solution that owes its activity mainly to ammonia and ammonium carbonate. The ammonia is later recovered by distillation and the copper thereby precipitated. This process was developed from the bottle stage in the laboratory to the present 2000-ton plant, in four years by the company's staff, assisted by the chemists of the Semet-Solvay Company.

Flotation has naturally checked any tendency to leach lean sulphide-copper ores. It is, however, a question whether roasting and acid-leaching of flotation concentrate may not seriously invade the field of the reverberatory furnace for copper recovery. This brings up the consideration of the changes during the half-decade in reverberatory-smelting practice. In 1911 oil-firing had become established wherever cheap fuel-oil was available. This led to a revival of attempts to burn pulverized coal in reverberatory plants where, owing to transportation costs, oil was at a disadvantage. First successfully accomplished in Canada at the plant of the International Nickel Co., the practice has been taken up at Anaconda with remarkable results, the capacity of the furnace, after slight enlargement, being doubled with practically the same fuel-consumption; or, stated differently, where one ton of coal smelted four tons of ore it now smelts seven. It has been found that the previous failures in coal-dust firing had been due mainly to insufficient pulverization. At least 75% must pass a 200-mesh screen, and this involves drying before crushing. The pulverized coal is blown into the furnace through a nozzle by means of a fan, and burns as easily as gas. This and other improvements have reduced the cost of reverberatory smelting 50c. per ton. This, taken in conjunction with the success of flotation, threatens to leave to the blast-furnace a narrowly constricted field.

Again, in copper metallurgy, converter-practice has seen a complete and revolutionary change in the last five years. Prior to that time the vessels in which the metal was blown to blister were lined with silicious material, which was consumed as a flux by the iron oxide liberated during the operation. Consequently frequent re-linings were necessary; in fact it was figured that each lining was good for about 20 tons of copper. Today, by the substitution of a basic lining for the silicious one formerly used, the production of copper for each re-lining has been as high as 20,000 tons. The lining is usually of magnesite brick, with a protective coating of magnesite artificially deposited by careful manipulation of the first charge. The silica for slagging the oxide-bases liberated in blowing is furnished by charging raw ore direct to the converter. Basic lining has permitted the use of larger units, has decreased the time of the operation, and hence the labor-cost per ton, and it has dispensed with the large and expensive force constantly required for the work of re-lining. It has been remarked that the new converter-plants present a deserted appearance by contrast with those of five years ago.

In the metallurgy of gold, of silver, and of lead there is little to record. Each of these seems to have reached a plateau in its development. Aside from the ubiquitous influence of flotation the progress has been slight. In silver metallurgy the rebellious ores of Nipissing have necessitated the development of a novel plan of desulphurizing with the aid of metallic aluminum prior to cyaniding, but it has not met with general application. Flotation may prove to be better. It looks as if there may be keen competition between cyanidation and flotation in the treatment of gold and silver ores during the next few years, with the odds on cyanide for gold and on flotation for silver.

In the field of ore-crushing as a preliminary to concentration, the tube-mill, viewed askance a few years ago, has found general adoption either in the conical or the short cylindrical form. American metallurgists have awakened to the advantages of the ball-mill, so long advocated by European and Australian engineers, and as usual they have improved the type, so that the short cylindrical or conical mill with alloy-steel balls will apparently displace other re-grinding devices.

Another field of metallurgical enterprise remains to be mentioned, that of by-product recovery. The days when smelters discharged into the atmosphere great tonnages of fume and dust are passing. With facilities

for the recovery of sulphuric acid from roasting-furnaces, and with an increased use for the acid as a lixiviant, an impetus has been given to the conserving of sulphur. With the development of careful methods for measurement of stock-losses lead and copper smelters, especially the former, have been able to determine their losses, and either with the baghouse or with Cottrell tubes have proceeded to stop the waste. The effect is an extension of the practice of by-product conservation.

If one dared to venture into the field of prophecy he would predict the growth of flotation and of hydrometallurgy, with a gradual encroachment of these upon the realm of pyro-metallurgy. The most significant feature of the progress here reviewed is that practically all of it has occurred west of the Rocky Mountains, under the direction of American and Canadian engineers and metallurgists, and as the result of sound technical training preceding their experience in practical application.

Rocks Forced Apart by Crystal Growth

*Many theories have been advanced to explain the origin of cross-fibre veins, particularly those of chrysotile. Most of these presuppose the existence of open fissures in which the vein minerals were deposited. It is conceivable that some cross-fibre veins may have been formed in pre-existing fissures, but in most cases this is mechanically impossible. In many instances there is evidence that the formation of chrysotile veins and the alteration of the enclosing rock to form massive serpentine, were contemporaneous processes; but the alteration of a rock to serpentine is usually accompanied by an increase in volume sufficient to close all appreciable openings. It has been suggested that chrysotile veins may have been formed by some process of replacement, but no one has explained why serpentine should replace serpentine of identical chemical composition. Moreover, chrysotile veins never contain pseudomorphs nor show trace of an inherited structure. Replacement veins are characterized by great irregularity in width and a lack of definite boundaries, while chrysotile veins are sometimes remarkably uniform in width, and always have well defined walls that are easily separable from the veins.

Cross-fibre veins with structural features similar to those found in rocks have been produced in the laboratory where their formation and growth could be observed. The evidence thus obtained supplements that furnished by veins of fibrous minerals, and makes inevitable the conclusion that cross-fibre veins are formed through a process of lateral secretion, the growing veins making room for themselves by pushing apart the enclosing walls. The force that enables the growing veins to push apart their walls is not due to the tendency of a crystalline substance to assume a regular polyhedral form, for the columnar or fibrous structure of most minerals occurring in cross-fibre veins is not a crystallization property, but is caused by the conditions of growth. Under similar conditions the fibrous structure will develop in substances that crystallize in any of the systems of crystallization. When a substance separates from solution with increase in volume, the pressure developed depends on the magnitude of the forces resisting expansion, and may be much greater than the force required to crush the substance. It is improbable that pressure alone can expel solutions occupying sub-capillary pores in rocks, and in serpentine and other rocks found enclosing cross-fibre veins, the openings are almost entirely sub-capillary in size. In such cases the transfer of material to the growing vein is probably due to diffusion rather than to circulation. The fibres are always parallel to one another and extend in the direction in which the walls moved as they were pushed apart by vein-growth. In most veins the fibres are normal to the walls because the latter have been forced directly apart, but when the walls have had also a lateral displacement, because of the simultaneous growth of adjacent non-parallel veins, or from other causes, the fibres grow in the direction of the resultant motion. If the course of the vein is not straight, the fibres may be normal to the walls at one place and oblique at another. As long as the relative motion of the walls of a growing vein is in a straight line, the fibres are straight; any change in the direction of motion is immediately recorded by the slowly lengthening fibres. If the change in the direction of relative motion is gradual and continuous the fibres are curved; if abrupt, it results in the development of sharp bends. Sometimes the fibres of a chrysotile vein record several changes in the relative movement of the walls, and this gives a banded appearance due to the unequal reflection of light where the fibres run in different directions. The fibrous structure is to be attributed largely to the mechanical limitation of crystal-growth through the addition of new material in only one direction. In the case of the asbestiform minerals the fibrous structure is accentuated by a normal prismatic habit and cleavage.

*Abstract: 'Origin of Veins of Asbestiform Minerals.' S. Taber; National Acad. Sci., December 1916.

Methods of Producing Sulphuric Acid in Germany

The production of sulphuric acid or sulphuric anhydride in Germany from plaster of paris in an electric furnace is vouched for by the eminent French chemist, M. Cazeneuve. The Germans are also treating plaster of paris with sand, producing silicate of lime and cement at the same time as sulphurous acid. Since the War Germany has had to look about for sulphur with which to make sulphuric acid, which partly explains the new process. Before the War Germany imported each year about 900,000 tons of pyrite from Spain for making sulphuric acid, and about 300,000 tons was mined in Germany. In 1912 and 1913 1,200,000 tons was imported each year from Spain. Besides these imports about 400,000 tons per year came from Norway, but this supply is not now available. Small quantities are probably now obtainable from Poland, Greece, and Turkey.

KIRKLAND LAKE MINE

The Kirkland Lake Gold District

By G. C. BATEMAN

Prior to 1910 gold was being mined in the province of Ontario at a few places only, and the production was small. In that year, however, development was started on a number of Porcupine properties, and when sufficient work had shown that the orebodies in that district would become important producers, search for new gold-bearing areas was extended to other parts of the Temiskaming district, so that discoveries were soon made at Swastika, Kirkland Lake, Long Lake, Munro township, and other localities in northern Ontario. The gold output from Ontario now represents more than half the total production of Canada.

Porcupine, with a yield of $9,397,536 in 1916, is, of course, the most important gold-mining district of Ontario, but Kirkland Lake, although it has only a small production at present ($702,761 in 1916), is developing rapidly. Taking into consideration the number of promising properties now being opened, it is easily the second most important gold camp in Canada. It may never rival Porcupine in tonnage or gross production, but it is of decided interest on account of the character of the ore, the geological conditions, and the number of properties that have been proved with a small amount of work.

The Kirkland Lake area lies in the district of Temiskaming, about 50 miles north of Cobalt, and 390 miles distant from Toronto. It is four miles from the town of Swastika on the main line of the T. & N. O. railway, and the properties being developed are in the townships of Teck and Lebel. The district is situated just south of the watershed between Hudson's Bay and the St. Lawrence river, and has an average elevation of 1050 ft. The country is rocky and hilly, but the hills seldom exceed 100 ft. in height. It is well wooded with spruce, poplar, birch, and pitch-pine, and as there is a large number of swampy areas, prospecting is somewhat difficult. The timber is suitable for mining purposes, buildings, and fuel. Kirkland Lake itself is of considerable size, and much more than sufficient to supply water for the entire district. The first staking of claims was done in 1908-9 by prospectors who came from the Larder Lake district, 15 miles to the east. A number of claims was staked in the areas containing the Temiskaming series of conglomerates, with the hope that cobalt-silver veins, similar to those at Cobalt, would be found. Feldspar-porphyry was new to the prospectors at that time, so they paid little attention to the Kirkland Lake area. The first discovery of ore was made on the Wright-Hargraves property in 1910, and in the following year an attempt was made at core-drilling with a shot-drill. Owing to the extreme hardness of the feldspar-porphyry, this was abandoned after two shallow holes had been put down. In 1912 gold was found on the Tough-Oakes property by the Tough brothers and Harry Oakes. Other gold-quartz veins were soon uncovered on the Teck Hughes, Lake Shore, Sylvanite, and Hunton properties.

In the winter of 1912 a winter-road was cut from Swastika to Kirkland Lake, and in December of the same year the first shipment of high-grade gold ore was made from the Tough-Oakes. This was followed by other shipments, and by the fall of 1913 sufficient work had been done to justify more extensive plans. Many of the engineers who inspected the mines during the first stages of development were skeptical of success, the principal objections being the narrow width of the veins at the outcrop and the uncertainty of the ore continuing into the feldspar-porphyry, which, in places, lay under the conglomerate and graywacke. They were also doubtful

as to the values that would be found over a stoping-width of from four to six feet. The most pronounced criticisms were made by German geologists and engineers who visited the mine in 1913. They were visiting Canada as delegates to the twelfth International Congress of Geologists, and were the guests of the Ontario government. The development of the Tough-Oakes mine to a depth of 500 ft. has proved that their fears were groundless.

In 1913 a geological map, to accompany the report on the district by A. G. Burrows and P. E. Hopkins, was issued by the Ontario Department of Mines. This work was of great assistance to the prospectors searching for the most promising areas, and to the operators in carrying out their development.

The rocks of the district are classified as follows:

1. Post-Temiskaming Intrusives: Granite, syenite, feldspar-porphyry (intrusive contact), lamprophyre.

2. Temiskaming Series: Quartzite, graywacke, conglomerate, with schistose derivatives.

Unconformity.

3. Keewatin: Greenstone (basalt, andesite, etc.), diabase, quartz-porphyry, feldspar-porphyry, iron formation, dolomite.

The Keewatin series has the widest distribution, and generally consists of greenstone, either massive or schistose. Where massive, these rocks are of small economic importance, but where sheared and intruded by light-colored acid rocks, they may be significant. The Temiskaming series was laid down on the eroded surface of the Keewatin and later infolded with the Keewatin and eroded, so that it is now highly inclined, and in the townships of Teck and Lebel, where most of the discoveries have been made, probably represents a syncline. The strike of the inclined strata is east, while the schistosity goes north-east. A peculiarity of the conglomerate is the presence of bright blood-red pebbles of jasper.

In the Post-Temiskaming series the feldspar-porphyry is the most important. It is generally red and fine grained, intruding the Temiskaming and found both as large masses and as narrow dikes. These dikes and masses trend in a north-easterly direction. Lamprophyre is prominent, but is much older than the other formations and has no connection with the ore deposition. Prospecting has shown a small area extending north-east, about 2½ miles long and 1 mile wide. In this area a number of gold-bearing veins has been found in the conglomerate and in the porphyry of the Temiskaming and Post-Temiskaming series. While the veins are usually found in the porphyry near the contact with other formations, in some cases they are in the conglomerate but pass from that formation into the porphyry. In the sheared conglomerate the veins are well defined, though narrow. In the porphyry there is often a series of quartz stringers and narrow lenses formed along the fracture-zone, producing a deposit of a stock-work type, with quartz veinlets intersecting the porphyry. The main fissures in the conglomerate are sometimes accompanied by subordinate fracturing, thus giving milling-ore over a width of several feet. The high-grade parts of the vein occur in narrow streaks, generally not more than 10 inches wide. The vein-material consists of white and bluish quartz, which shows the result of repeated fracturing, inclusions of porphyry fragments, and highly silicified country-rock. In some places there is much cementation with calcite. Sulphides, largely iron pyrite, are present, and there is a small amount of copper, lead, and zinc. An interesting feature is the extensive deposition of molybdenite, which usually occurs as a thin film on the fracture-planes. In some of the mines there is considerable free gold, and tellurides are found in almost all the veins. The tellurides present in the ore are altaite, tetradymite, hessite, and probably calaverite. Altaite, the telluride of lead, is the most abundant. It is possible that the molybdenite and altaite may have had some influence upon the enrichment, as experiments have shown that both these minerals will precipitate gold from a chloride solution. Gold tellurides occur in limited amounts, the quantity not being sufficient to contribute much to the value of the ore. Shipments of high-grade ore show a higher proportion of silver than gold, and this is probably due to one of the gold-silver tellurides. The gold is generally free or is associated with the sulphides.

There appears to be a principal zone of fracturing along which the known mines are distributed. Recent development, however, indicates the possibility of at least one other zone, and it is likely that with further work others may be discovered, and the area still further extended. It is a peculiar fact that the shafts of the five principal properties, along a zone more than two miles long, are in a straight line. The ore deposits have been formed at considerable depth and have been exposed by erosion. On the Tough-Oakes and Wright-Hargraves properties there are surface exposures that are indicative of the richness at the lower levels, but on the remaining properties, sufficiently developed to give promise of becoming productive mines, the surface exposures are not as good as have been found at depths of from 100 to 300 ft. This increase of richness in depth is not due in any way to enrichment by descending solutions, but to the fact that Glacial erosion had not, at those points, been carried sufficiently deep to expose the better portion of the veins.

The most easterly development is the Tough-Oakes mine. It is the only mine as yet productive, and is developed to a greater extent than any other in the district. Ore was first discovered in 1912, and from an open-cut on the No. 2 vein, 225 tons of an average grade of $350 was shipped to the smelter. All of this ore was washed and picked on bumping-tables, the fine and reject being sent to a 5-stamp mill, where about 50% of the gold-content was extracted by amalgamation. The residue was treated in the cyanide-mill and averaged $14 per ton. Development on the No. 2, as well as on other veins discovered, was so satisfactory that it was decided to build a new mill of about 120 tons per day capacity. The mill was built by the Butters-Johnson

Engineering Co. J. A. Baker, now on the staff of the Dorr Company, was in charge of construction. Work was started in 1914, and in March 1915, just three years after the commencement of mining, the mill was started.

The ore is hoisted from the mine in 1¼-ton skips, which are weighed as they enter the crusher-station. It is crushed in a 20-in. Buchanan crusher, and then passes through a trommel with 1¼-in. holes. The oversize goes to a 12-in. crusher, the product then passing to the fine-ore bin on a 12-in. conveyor-belt. From this bin it is fed to a short conveyor by three plunger-feeders and thence to the ball-mill.

The primary grinding is done in a 6-ft. Hardinge conical ball-mill with a 16-in. barrel. It is driven by a 40-hp. motor, and the counter-shaft has a plamondon clutch. The ore is ground in cyanide solution, the moisture of the mill-pulp averaging 54%. The ball-mill load is 11,000 lb., and consists of 25% of 1½ to 2-in., 40% of 2 to 3-in., and 35% of 3 to 6-in. sizes. In the discharge-end is a steel-wire screen that carries off the oversize, which is returned to the feed-end. The ball-mill product flows to a Dorr duplex classifier, and the underflow goes direct to the No. 1 thickener. The oversize goes to a 5 by 20-ft. tube-mill, and the discharge to a second Dorr classifier, thence to another tube-mill for re-grinding. Both of these tube-mills are in closed circuit. Screen analyses show that 85% of the ore is ground to pass 200-mesh. As 85% of the gold is dissolved in the grinding circuit, the pregnant solution from No. 1 thickener flows to a Butters type clarifier containing 12 canvas leaves. The solution is drawn through these leaves with a Goulds vacuum-pump, and is sent to the pregnant-solution tank. The pulp from the No. 1 thickener is transferred with a duplex pump to the No. 1 Dorr agitator 6 by 16 ft. and thence through the others by gravity flow.

From the agitators the pulp is washed in four 28 by 12-ft. Dorr thickeners, and the water is introduced in No. 5. The solution is handled by two Guynnes centrifugal pumps of the four-bearing type. The pregnant solution is drawn from the tank by an Aldrich triplex pump and the zinc-dust emulsion is introduced from a Merrill feeder ahead of the pump. The precipitate is recovered in two 16-frame Merrill filter presses. The zinc-dust consumption is 0.77 lb. per ton of ore treated and 0.16 lb. per ton of solution precipitated. By

MAP SHOWING THE MINING DISTRICTS OF ONTARIO

feeding the minimum amount of zinc-dust the value of the precipitate is increased to $60 or $80 per lb. and the weight reduced very much. This also eliminates the necessity for the acid-treatment of the precipitate. The ratio of a ton of solution precipitated to ore treated is five or six to one. The precipitate is dried to about 6%, and charged with fluxes into a No. 295 graphite crucible, and melted in an oil-fired tilting-furnace. The bullion is worth $14 per ounce. Power for the mill and the plant is at present supplied from a hydro-electric plant at Charlton. This supply, however, is uncertain, and is not sufficient for the needs of this one mine. A new line has been built from Cobalt, 50 miles away, and will supply all the power needed in the district.

During the year 1916 the mill treated 37,263 tons of ore, averaging $20.10, and 2600 tons of stamp-mill tailing, averaging $13.52. The total recovery was $711,000, the production to date being about $1,380,000. Pregnant solution precipitated per month was 15,655 tons, with an average assay of $3.57. The barren solution assayed 0.09c. The dry precipitate recovered per month was 867 lb. with an average assay of $67.16 per pound. The supplies per ton of ore treated during the year were: 1.59 lb. steel balls, 4.29 lb. of pebbles, 1.24 lb. of cyanide, and 3.26 lb. of lime. The cost per ton of ore milled was $2.43 per ton, made up as follows:

Labor	$0.54
Supplies	1.15
Power	0.52

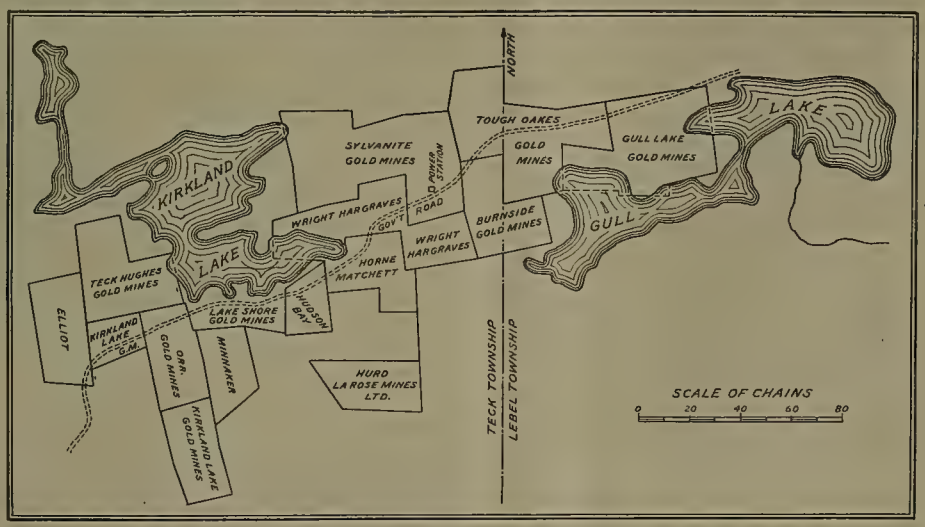
The company is working a number of veins, which vary in width from a few inches to six or seven feet. By reason of the narrow width of quartz, at least 85% of the ore milled is made up of feldspar-porphyry, and in some places the vein-quartz does not represent more than 10% of the whole. In places, however, there are swells in the vein that give a stoping-width up to 16 ft. Last year 4153 ft. of development work was done. Ore reserves are estimated at a total value of $1,000,000. The company has an issued capital of 551,000 shares of $5 par, and pays dividends of 10% yearly. After the payment of dividends there was a deficit of $66,000 for the year. This is accountable to the high cost of supplies and the shortage of power, which seriously curtailed operations.

The Sylvanite and the Burnside proporties adjoin the Tough-Oakes on the west. Only a small amount of work has been done, but the properties are of considerable merit on account of their location and surface exposures. Unfortunately, however, the Burnside has been lying idle owing to various legal entanglements, and it does not look as if these are likely to be cleared up in the near future. Work on the Sylvanite will be started shortly. When first staked and before the discoveries on the Wright-Hargraves and Tough-Oakes, the Burnside property was considered to be of little merit, and the man who grubstaked the locator thought so little of the claims that he refused to put up the money for the first 30 days' work. Three more fortunate individuals who each put up $10 for a one-twenty-fourth interest subsequently received $10,000 each when the property was sold. The Wright-Hargraves, adjoining the Sylvanite on the west, is one of the most promising properties in the district, but, unfortunately, in this case also there was dissension among the owners, and this property lay idle until a few months ago. The difficulties were then adjusted, and a company was formed to take over the various interests. Sufficient capital was obtained, a plant installed, and development work started. There are two known veins on the property, both of which are in the porphyry. From the smaller of the veins a shipment of three tons gave returns of $400 per ton. The main vein, which in places has a width of 20 ft., has been traced for a distance of 2000 ft. by shafts and stripping. Sufficient work has not been done to show the extent of ore in this length, but the property gives promise of becoming a substantial producer. Near the east shore of Kirkland lake a shaft has been sunk to a depth of 100 ft. The vein at this point is 13 ft. wide, and the average assay in the shaft, which is on the richer portion of the vein, is between $25 and $30 per ton. Seven hundred feet away another shaft is being sunk in ore. The company is capitalized at 2,500,000 shares of $1 each, 700,000 of which remain in the treasury. The next property along the strike of the main zone, and adjoining the Wright-Hargraves on the west, is the Lake Shore. The surface showings were not particularly promising, and the preliminary development would, to most men, have been discouraging. The owner, however, who was one of the original stakers of the Tough-Oakes, continued development until good ore was cut. An ore-shoot, 300 ft. long and averaging over $15 per ton over a width of 4 ft., has been developed on the 100 and 300-ft. levels. The vein is in the porphyry, near the contact with the conglomerate. Other shoots and other veins will also probably be discovered. The company has ordered part of the equipment for a 50-ton mill. The Teck Hughes lies west of the Lake Shore. Work was done by different interests, and the property was finally acquired by the Buffalo Mining Co. of Cobalt. Several veins have been found and a considerable tonnage of ore developed. At the No. 3 shaft there has been developed 27,000 tons, averaging $20.63, over a width of 6 ft. This is the only working where the company makes an estimate of the ore reserve, but a number of other important orebodies have been disclosed. In the No. 1 vein a new shoot has been cut; this shows 27 in. averaging $150, and another shoot intersected by a cross-cut to the same vein shows 20 in. of $273 ore. On the No. 3 vein the first level shows 5 ft. of $10.50 ore, and the second level 4½ ft. of $20 ore. A new shoot, the longest in the mine, has been cut on this vein; it has been developed for a length of 200 ft., and averages $7 per ton. The mill-feed is expected to run about $15 per ton. On account of the narrow width of some of the veins the dilution from waste rock is high. A mill has been completed and it is expected to start operating in March. It was ready some time ago, but the company was awaiting the delivery of power from Cobalt. The ore from the mine is delivered to Blake

crushers. The crushed ore is sent to a 5 by 5-ft. ball-mill, the discharge going to a Dorr classifier and a tube-mill, using steel balls, the classifier and the tube-mill being in closed circuit. The continuous counter-current decantation system is used, and the solutions will be changed on the pulp when the treatment is two-thirds over. By the removal of solution high in gold, and the addition of active barren solution, an additional recovery is anticipated. Double-tray thickeners are used, and the pulp is washed on an Oliver filter. The filter is expected to reduce the mechanical cyanide losses as well as to effect an additional recovery. West of the Teck Hughes is the Kirkland Lake mine, which is under option to the Beaver Mining Co. It is being developed energetically, and a shaft is now down 500 ft., with a level at each hundred feet. On the surface there was only a small exposure of high-grade ore, and nothing of much importance was developed until a point below the 200-ft. level was reached. On the 300-ft. level three high-grade veins were found, while the porphyry between was mineralized and intersected with quartz stringers, which assay well. It is stated that on the 300-ft. level there is, in one place, a width of 42 ft. that will average $9.50. On the 400-ft. level the development to date gives an average assay of $18 over a width of from five to six feet. Some driving has been done on the different levels, but the company has been hampered by small compressor-capacity. A new plant has, however, been ordered. It is estimated that over $500,000 worth of ore has been developed to date. In the latter part of February the company made the first payment of $75,000 on the property.

The success attending the development of the Kirkland Lake mine has resulted in operations being started on properties still farther west, and it is possible that the present westerly limit of the known mineralized area will be extended. Several other properties south of the main zone are now being worked, and while some discoveries that may be of importance have been made, on none of the properties has sufficient work been done to justify an opinion as to their real value. Very little prospecting has been done outside of the main zone, but in view of the favorable geological indications, and the satisfactory development of most of the properties, it is a fair assumption that other mines will be discovered.

STOPE IN THE TOUGH-OAKES MINE



THE PRINCIPAL MINING PROPERTIES OF KIRKLAND LAKE

It can be definitely stated, however, that nowhere in Canada is there a gold-mining district where such good results have been obtained for such a small amount of development work.

The Government has built a good wagon-road from the railway to the mines, and the settlement is excellently provided in the matter of telephone, telegraph, and train service. One can step out of a Pullman at Swastika and in less than an hour's drive arrive at the Tough-Oakes mine, which is farthest from the railroad of any of the operating properties. The mining industry of Ontario is fortunate in the service that is rendered by the Provincial Geologists. Their reports on the different mining districts, which are published as soon as, and often before, anything of interest is discovered, are comprehensive and extremely valuable as an aid to prospecting, exploration, and development. This is nowhere more evident than at Kirkland Lake, and acknowledgments are due to them for the geological information contained in this article.

No Oil Sands in Mexico

*Few people know the geological structure of the Mexican oil-fields. No one in the world today knows it perfectly. Nothing yet uncovered in the United States resembles the underground formation in Mexico. In California they pump from well-defined areas of oil-sands two to three thousand feet deep. The porosity of oil sand is about 14%, and those wells do not average 200 barrels per day. But there are no oil sands in Mexico. About 2000 ft. below the level of the sea the drill strikes the bed of ancient oceans and from coral reefs with 60% porosity spurt the greatest oil wells in the world. No pipe-line yet constructed has been able to receive the full measure of one of these gushers. South of Cerro Azul is the great Potrero oil well of the Mexican Eagle or English company. It gives the entire 40,000 bbl. per day that this company can export with its existing shipping facilities, but this is not half of its capacity. Lord Cowdray is giving his whole time to his country at the head of the British aviation department, so essential on land and sea in winning the War, and his pipe-lines and refineries work automatically on the Mexican coast. When the War is over this field may compete for his great organization and engineering talent. To the north, near the terminus of the Mexican Petroleum Co.'s railroad at San Gerónimo, on the borders of the Tamiahua lagoon, still rises a cloud of steam from the ruins of the famous well of Dos Bocas. Here in 1909 unexpectedly came in the world's greatest gusher. Through an 8-in. casing shot a column into the air 1500 ft. high by actual theodolite measurement, belching 300,000,000 bbl. of liquid per day. How much of it was oil nobody could say. The torrential flood reached the boiler fires and soon, in place of an 8-in. casing, was a heavily seething mass, 100 acres in extent.

Boston News Bureau.

Selective Flotation Applied to Zinc Blende

Experiments on selective flotation, made by J. M. Callow and his staff, have developed interesting features that have been put into practical use at the Utah Apex mill at Bingham, Utah, and at the Magma Copper Co.'s plant at Superior, Arizona. The method employed in the latter mill has been outlined in a paper, 'Notes on Flotation—1916,' by Mr. Callow, published in the transactions of the American Institute of Mining Engineers in February. The zinc is raised in preference to the pyrite by using 34° B. fuel-oil in combination with No. 17 oil of the General Naval Stores, and adding 0.1 lb. copper sulphate per ton of ore treated. The function of the copper sulphate is not understood, but it has been suggested that it may act as an electrolyte, although sulphuric acid, which had formerly been used, had failed to yield zinc concentrate with a low insoluble content. Part of the galena in the ore was removed before flotation by table-concentration, and part of it was floated with the zinc, from which it was separated afterward by tabling the flotation-concentrate. The mill-feed at the Magma copper plant averages about 185 tons per diem, and the cost of the flotation alone is about 34c. per ton of crude ore, exclusive of filter-pressing the concentrate, which adds about 7c. per ton. The total milling cost is about $1.10 per ton, in which is included 22c. for sorting. No general expense or overhead charges enter into the foregoing figures.

At the Utah Apex plant an entirely different method is applied. The ore treated contains zinc-blende associated with a preponderating amount of pyrite. The oil-mixture employed consists of 33% No. B-14 wood-tar (U. S. Naval Stores Co.), 67% No. 150 pine-oil (Pensacola Tar & Turpentine Co.), this mixture being added at the rate of 2 lb. per ton of ore. Sulphuric acid in the proportion of 1 lb. and salt-cake 100 lb. per ton of ore are also introduced with the pulp flowing into the Callow cells. The result is to lift out the zinc-blende quite free from pyrite. A curious circumstance is that by increasing the amount of salt-cake to 150 lb. per ton of ore, the effect is exactly reversed, the pyrite being floated and the zinc left in the residue. The impossibility of predicting the adaptability of a method to any particular ore from a consideration of superficial likeness in character is brought out forcibly by the failure of the Magma mill-pulp to respond to a like treatment. Each ore presents its own peculiar problems, and the possibilities of making combinations of flotative agents and assistants to bring about physical conditions favorable for floating different minerals seem to be infinite.

SHALES AND SANDSTONES occasionally carry gold and silver in payable quantity. The silver-bearing shales and sandstones of Silver Reef, Utah, and the gold-bearing sandstone of Lawrence county, South Dakota, are among the examples. Extensive auriferous sandstone beds have been found in Central Africa.

Beneficial Effect of Grinding With Steel Balls for Flotation

By VICTOR ZACHERT

Ore as extracted from the mine contains, with few exceptions, a certain percentage of comminuted material generally termed slime, in which also exist the metalliferous constituents of the ore. This comminuted material is the result of nature's disintegration, and in this instance to designate the slime correctly an appropriate term would be 'natural,' instead of 'primary.' Primary slime may be misinterpreted as the slime produced artificially at some stage in the process of ore reduction. While natural slime is detrimental to flotation treatment, artificial slime is not so. Experience with many ores that have been subjected to flotation treatment has shown that the best results are obtained when the mineral has been freshly fractured by crushing of the ore. To explain this phenomenon the influence and effects produced by the presence of all the elements, both physically and chemically, must be considered. When a solid body is made to change its physical characteristics by altering its structure or position, a certain amount of resistance is offered, resulting in the evolution of heat. In the case of an ore from which the enveloped metalliferous constituents are to be liberated, the practical methods available are to crush the ore either by compression or attrition. In both bases resistance must be overcome and heat produced. The rise of temperature has been often verified when grinding ore in a tube-mill for cyanidation. The heat is so intense on the lines of rupture of the particle that the mineral is subjected to chemical changes, resulting in the decomposition of the minerals (including the sulphides). The chemical change, however, does not extend throughout the entire particle, but sufficient superficial change has been effected to alter its characteristics owing to the formation of gaseous films, and an oil, adhering more readily to the mineral enveloped in such a film, will select it in preference to one enclosed by a water-film. The reason why minerals in the natural slime are refractory to flotation treatment is that the gaseous films developed during disintegration of the ore in nature have long ago vanished, though the necessary condition may be restored by friction with coarse ore. "While the re-ground oversize yielded remarkably lean tailings," states Rudolf Gahl,* "the product containing the primary slime could not be treated advantageously by flotation. We were almost on the point of concluding that in order to get the best results, a separation of the primary slime should be made in the large mill, and flotation should not be relied upon entirely for the treatment of the slime. Before finally deciding this, however, additional laboratory experiments were made to ascertain the influence of the primary slime on flotation. These tests established one fact quite well, which is, that when refractory slime is mixed with a sufficient quantity of coarse ore ground to the necessary fineness, in other words, when the percentage of primary slime in the flotation-feed is kept low, the slime loses its refractory character."

The natural slime in the ore is a point that should not be indifferently regarded by the flotation metallurgist, and its character, quantity, and influence upon the flotation results should be carefully observed and considered. One may be laboring on the solution of a flotation treatment-problem, and at the same time be entirely unaware that the impediments to success lie in the deleterious action of the natural slime. In determining the adaptability of an ore to the flotation process, the sample of ore that is to be subjected to test should receive a preliminary water-wash to remove the natural slime, and the latter should be investigated independently of the coarse portion of the sample. In many instances, especially when the valuable constituents of the ore predominate in the natural slime (or the slime of accumulated tailings, which may also be classified as natural slime) a separate treatment of the two products may be necessary.

As regards artificial slime, the nature and composition of the grinding medium also has an influence upon the final flotation results, a fact which has been practically demonstrated at the Inspiration mill, where steel balls have been substituted for flint pebbles in the grinding-mill, immediately giving an improvement in the extraction by flotation. On this matter Rudolf Gahl† says, "While these tests were in progress, we made another useful discovery. In our tests on the most economical way of reducing the ore to the fineness necessary for flotation, we had, among other machines, a ball-mill in competition with pebble-mills. In the ball-mill, steel balls performed the duty that in pebble-mills was done by flint pebbles. For awhile, the ball-mill discharge was treated on one flotation machine, while the pebble-mill discharge was treated on a group of others. While this flow-sheet was being followed we thought we noted that a flotation machine treating the ball-mill product showed the influence of the primary slime to a less extent than the flotation machine treating the pebble-mill product. In a discussion with Dr. Ricketts and Mr. Mills, the question was raised as to whether the iron introduced in the

*'History of the Flotation Process of Inspiration.' By Rudolf Gahl. M. & S. P., Sept. 30, 1916.

†'Notes on Flotation.' By Rudolf Gahl. M. &. S. P., Sept. 23, 1916.

pulp by the attrition of the balls might not have something to do with the fact. The question was accordingly made the subject of some laboratory experiments. The results of the experiments proved conclusively that the iron had a beneficial influence on flotation in counteracting the harmful effect of the primary slime. This discovery was one of the inducements for installing ball-mills in the big concentrator plant, while originally pebble-mills had been considered for this purpose. We have not yet reached a point where we can safely give the reason for the action of the iron introduced into the pulp."

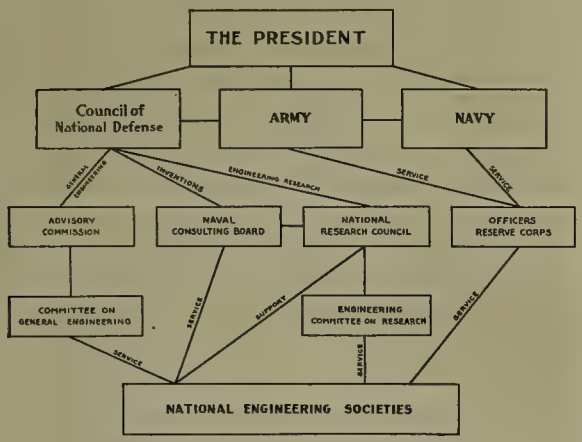
So far no satisfactory explanation has been advanced to account for this beneficial effect on the extraction by flotation in changing from pebbles to steel balls. An effort to determine the possible cause of this improvement has led to the conviction that magnetism plays an important function in the matter. When movement is imparted to two steel bodies, so that friction is developed between them, they acquire magnetic properties. This may be experimentally demonstrated by drilling a hole with a steel drill in a piece of soft steel. After a few turns of the drill, an examination will show that small fragments of the steel borings adhere to its end, indicating that the drill has acquired magnetic properties. Another experiment to demonstrate magnetization by friction of two steel bodies, but to a less extent, is by forcibly stroking a needle several times over the surface of a good steel file. The needle will then possess magnetic properties. In crushing ore by means of steel balls, some of the steel is scoured off the balls by abrasion, and forced into the pores of the minerals, giving the minerals magnetic properties, resulting in attracting one to another and collecting them into a mass. This mass is further attracted by the magnetized steel balls. It is much easier to incorporate oil with the mineral when it exists in the form of an agglomerated mass than when the mineral is disseminated through the pulp in a state of minute subdivision.

A requisite in the flotation process is the proper oiling of the mineral particles. To accomplish this demands care on the part of the flotation-metallurgist. In the majority of instances where flotation is practised, oiling of the mineral is done at some period following fine grinding and prior to or during flotation. The most effective and reliable method by which this can be done is to incorporate the oil with the metalliferous matter by grinding the ore in the presence of oil or of an oil-bearing substance; however, this procedure is effective only when the metalliferous matter is not in too fine a state of subdivision. It may and often does occur that during grinding the mineral which has received proper oiling will again lose its coating before approaching the discharge-end of the grinding-mill. My investigation has shown that magnetism is of extreme importance in causing the mineral of the natural slime to yield readily to flotation. Another experiment was made to determine if the results could be improved by increasing the magnetic force within the grinding zone; therefore the steel balls were magnetized by means of an electro-magnet and then introduced into the grinding-mill with ore, water, and a small quantity of oil. Immediately the beneficial effect of the increased magnetic properties could be observed by the discoloration of the pulp after grinding. The ore selected for this experiment was composed of chalcocite in a white quartz gangue, all of which passed a 40-mesh screen, and the pulp in appearance resembled ground coal-dust. This sample, when reduced in a small ball-mill provided with magnetized steel balls, and ground to pass a 60-mesh screen, was seen to be composed of snow-white quartz mixed with occasional specks of agglomerated particles of oiled chalcocite, averaging in size from minus 60 to plus 100-mesh. To determine the fineness of these agglomerated particles of chalcocite a portion was washed in gasoline to remove the oil. After filtering and drying, 80% of it passed a 200-mesh screen. On examining this fine material it presented a moss-like appearance, indicating that the minute particles of the chalcocite still retained magnetic properties, and the moss-like appearance was due to agglomeration from the magnetic attraction which each particle of mineral exerted individually. Means were not available for making quantitative determinations for the purpose of computing the percentage of extraction. The main object of the experiment was to study the influence and effects produced by grinding the ore under conditions to induce magnetism. In conclusion, I may state that the discovery and corroboration by experiment proves that magnetism performs an important function in the preliminary preparation of ore for flotation-treatment, and leads to an explanation of the phenomenon causing a beneficial influence in flotation when grinding the ore in a ball-mill.

CHROMIUM, MOLYBDENUM, TUNGSTEN, AND URANIUM are closely affiliated chemically and all form acid trioxides like that of sulphur, SO_3. Chromium forms also the stable basic oxide Cr_2O_3 which resembles ferric oxide in its properties. It forms in silicate environment and is a constituent of igneous rocks. In sulphide deposits chromium is dissolved and re-precipitated, but so far as any evidence is available it is not very migratory. Molybdenum and tungsten oxidize slowly to secondary minerals which generally remain near the parent primary minerals. Molybdenite is not dissolved in hydrochloric acid nor in sulphuric acid, nor, at the end of one month, in the presence of ferric salts. Tungsten forms tungstic acid, $H_2WO_4H_2O$. This is somewhat soluble in water. In moist climates, it could be leached out of deposits which were exposed long enough, but the reaction is exceedingly slow. Tungsten minerals are so insoluble that they commonly form placers. Both molybdenum and tungsten are classed with the non-migratory metals. Uranium, on the other hand, is carried in underground waters and doubtless forms secondary deposits of considerable importance. The deposits of south-western Colorado, as already stated, are believed to be re-concentrations by ground-water near the present surface.

National Engineering Societies and National Service

The administrative organization for the conduct of the War is set forth on the accompanying diagram, showing the mechanism for the contributions to be made by the national engineering societies. This diagrammatic expression of the co-ordination of the engineering talent of the country was prepared by Philip N. Moore and Bradley Stoughton to show engineers through what channels their services might be made available. With the exception of the direct contribution to military and naval operation as trained specialists serving in the Officers' Reserve Corps, all civilian technical effort is finally co-ordinated for Government service through the Council of National Defense, which stands next to the President, and serves



WAR-ORGANIZATION OF ENGINEERING SOCIETIES

as his right hand in maintaining and utilizing the industrial competency of the Nation in this hour of crisis. The Council of National Defense is composed of four Cabinet Officers assisted by eight civilians, namely, Daniel Willard, chairman, president of the Baltimore & Ohio Railroad, Howard E. Coffin, an engineer of the highest ability and vice-president of the Hudson Motor Co., Dr. Hollis Godfrey of the Drexel Institute,, Samuel Gompers of the American Federation of Labor, Julius Rosenwald of Sears, Roebuck & Co., Bernard H. Baruch, a banker, Dr. Franklin H. Martin, and Grosvenor B. Clarkson, secretary to the Board.

The Advisory Commission of the Council of National Defense is composed of civilians who are chairmen of committees on Engineering, Finance, Agriculture, etc. Dr. Hollis Godfrey is a member also of the Advisory Commission and chairman of its Engineering Committee. The President and Secretary of the American Institute of Mining Engineers likewise have been appointed members of the Engineering Committee. This Committee articulates directly with the Council of National Defense on all matters of general engineering, and it calls upon the individual members and resources of the National Engineering Societies for service in connection with general engineering matters, not including inventions which belong in the field of the Naval Consulting Board, nor research which is looked after by the National Research Council.

The Naval Consulting Board was appointed by the President of the United States upon nominations made by the National Engineering Societies and others. The American Institute of Mining Engineers is represented on that Board by W. L. Saunders, who serves as its chairman, and by Benjamin B. Thayer. Six other members of the A. I. M. E. are also members of the Naval Consulting Board. This Board articulates directly with the Council of National Defense and advises upon all questions having to do with the investigation and development of inventions for the use of the Army and Navy Departments and any other branch of the National service; it does not, however, articulate directly with the Government Departments, but reports to the Council of National Defense.

The National Research Council was formed by the National Academy of Sciences at the request of President Wilson. The National Academy of Sciences was formed during the Civil War for the purpose of assisting the Government. The National Research Council's organization and operating expenses, but not its research expenses, are paid by the Engineering Foundation, which is a creation of the United Engineering Society. The National Research Council co-operates with the Naval Consulting Board and the Council of National Defense in all matters having to do with research, but not with inventions nor with general engineering.

The American Institute of Mining Engineers is represented on the Engineering Committee of the National Research Council by Pope Yeatman and Albert Sauveur. Other members of the A. I. M. E. are also on this committee.

The Officers' Reserve Corps was developed by a Joint Conference Committee of the national engineering societies and became law by Act of Congress in July, 1916. Application-forms for a commission in the Officers' Reserve Corps, Department of Engineers, can be obtained from the War Department, Washington, D. C., or from the secretary of the American Institute of Mining Engineers.

It is desirable to obviate duplication of effort. Multiplicity of organizations throughout the country for patriotic service is a feature of the first impulse before riper experience shall have shown how they should be co-

ordinated so as not to overlap and interfere. The State Geologists and the U. S. Geological Survey, for example, should arrange for a division of work in giving information concerning probable new sources of metals and industrial minerals, so that each may do that for which it is best fitted. Several of the States, among which is California, have organized their own Councils of Defense, appointed by the Governors. An organization of this kind is practically certain to expend useless effort, unless its work be co-ordinated with the federal or national bureaus and committees. This is apparent to the members of these State Councils, and so far their efforts have been directed chiefly toward taking a census of resources, physical and other, which will necessarily be helpful to the Council of National Defense. The political motive back of the laws creating these local organizations seems to have developed out of the historic insistence upon State's rights. It is not to be condemned since it shows that the democratic spirit that is unwilling to relinquish too much of its authority to centralized control is still vital. It is well enough to keep the ideals of independent self-government in evidence; meanwhile it is to be hoped that the conception of responsibility for actual defense, as a movement apart from the Federal forces, be not taken too seriously. Local direction of production in harmony with the national requisitions, coupled with the maintenance of an effective rural police having wider jurisdiction than county officers, would render the State Councils a most useful aid to the general endeavor of national-committee work.

Hybinette Electrolytic Nickel-Refining Method

*The bessemerized copper-nickel matte, containing about 47% nickel, 33% copper, and 20% sulphur, with usually less than 0.4% iron, is granulated and roasted. It is then leached with a 10% solution of sulphuric acid to dissolve the major part of the copper. The residue is melted and cast into anodes, which contain about 65% nickel and from 3 to 8% sulphur, with traces of copper and iron. The electrolyte used for the nickel carries 45 grammes nickel, and from 3 to 5 milligrammes of copper per litre, and is supplied by rubber tubes to the cathode diaphragms. After circulation it has from 2 to 3 gm. copper per litre, and is passed over waste anodes which deposit the copper and re-supply nickel to the solution. The action of the anodes is analogous to that of pig-iron in precipitating cement-copper, except that the copper is deposited by nickel instead of by iron. The amount of waste-anode resulting after electro-deposition of the nickel is about 40% of the original weight, and is sufficient for rejuvenating the exhausted solutions from the nickel vats. The solutions never have to be rejected as they are sufficiently purified by the cementation. Waste fragments, after the cement-copper has been brushed off, are crushed, roasted, leached with 10% sulphuric acid to dissolve more copper, and the residues are melted into anodes and re-electrolyzed. The anodes for the nickel department are enclosed in special canvas bags, stated to last 18 months. Paper diaphragms supported by common canvas at times have been substituted and have lasted 12 months. The cathodes are of iron treated with a wash of powdered graphite. The nickel deposits on both sides of the cathode-plate. These plates are arranged in parallel. The voltage is from 3 to 4 v. per tank, according to current-density, which varies from 8 to 10 amp. per square foot. The large tanks contain 20 cathodes and 21 anodes, and the smaller tanks 10 to 14 cathodes and 11 to 15 anodes. The deposition of the nickel takes about 15 days, and the sheets stripped from the cathodes weigh 20 to 30 lb. each. They are about $\frac{1}{8}$ in. thick, and have the usual corrugated warty appearance, but the stalactitic growths are dense and give no trouble through short-circuiting. The sheets are washed in weak sulphuric acid to remove basic salts, are dried, and cut into 2 to 3-in. strips for market. The metal is guaranteed 99% pure, with usually no more than 0.03% copper. The precious metals accumulate in the anode-slime, which is re-melted into anodes and separately electrolyzed, the final slime being caked, dried, and sold for its precious-metal content. The copper is separately deposited, but on copper sheets and without encasing the insoluble lead-anodes in bags. The current-density is about 10 amp. per square foot at 2 v., and there are usually 9 cathodes and 8 anodes per tank. The high-tension current is first stepped down to 220 v. (alt. cur.) and then converted to direct-current at a voltage between 160 to 170 v. This process is carried out in Norway on matte from Evje and Ringerike, where power costs about $13.50 per hp. yr. It will be applied at the works of the British America Nickel Corporation, Ltd., at the Murray mine, near Sudbury, Ontario. The American patents covering the process are No. 805,555, 805,969, 1,128,313, and 1,128,316, all of which have been assigned to the National Trust Co., Ltd. of Toronto.

*Abstract: Report of Ontario Royal Nickel Commission, 1917.

ZINC-EXTRACTION, according to a method being exploited by the Minerals Products, Ltd., is reported as follows: The ore or concentrate is roasted to a low sulphur-tenor, converting the metals into oxides; it is then triturated and treated with a boiling solution of ferrous sulphate which dissolves the zinc as per the reaction:

$$2ZnO + 2FeSO_4 + 2H_2O = 2ZnSO_4 + Fe_2(OH)_4$$

The operation is accomplished at normal temperature and pressure and without aeration. It is said to be specially applicable to zinc ores containing lead. The manner of dealing with the problem of filtration is not stated. This would seem to offer difficulty in the case of a gelatinous precipitate such as ferrous hydrate.

MANGANESE is in such sharp demand that a contract for Brazilian ore has just been closed at $1 per unit. Ferro-manganese has soared to $450 per ton.

Lead Production in 1916

Statistics of lead produced in the United States, compiled by C. E. Siebenthal for the U. S. Geological Survey, show an output of 571,134 short tons of primary refined metal, being an increase of 3.8% over the amount reported for 1915. The total lead, both smelted and refined, amounted to 615,127 tons, of which 596,221 tons came from domestic ores. Missouri leads with a production of 218,253 tons of lead, followed closely by Idaho with 170,059, while Utah stands third with 111,789. The next highest producer is Colorado, which turned out 33,046 tons. Imported ores and bullion added 18,906 tons to the total production. The recovery of lead from zinc residues reached the important figure of 5478 tons. The following tabulated statement reveals the situation as to stocks of the metal, and movements to and from the country:

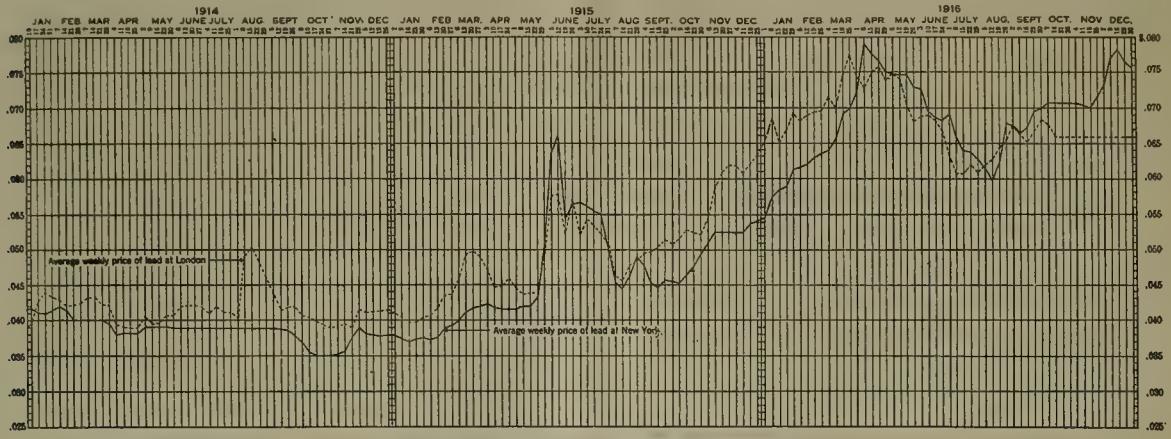
REFINED PRIMARY LEAD

Supply:	1914	1915	1916
Stock in bonded warehouses Jan. 1.	5,310	7,668	12,169
Imports—			
For consumption	7,386	9,680	12,771
For warehouse	20,952	41,816	22,559
Increase by liquidation	.....	2,250	5,642
Production from domestic ores	512,794	507,026	552,228
Total supply	546,442	568,440	605,369
Withdrawn:			
Exports of foreign lead—			
From warehouse	21,545	38,618	9,880
In manufactures, with benefit of drawback	9,399	3,983	5,171
Exports of domestic lead	58,722	87,306	100,565
Decrease by liquidation	56	.....	.....
Stock in bonded warehouse Dec. 1.	7,668	12,169	12,369
Total withdrawn	97,390	142,076	127,985
Available for consumption	449,052	426,364	477,384

The imports of lead show the effects of the current wars and revolutions in a striking manner. South America has practically held its own, sending us a total of 6,235,758 lb.; Canada has leaped from 338,569 lb. in 1913 to 12,606,216 in 1916; and Mexico has declined from 95,693,439 lb. in 1913 to 48,395,670 in 1916, but the great height as producer from which that country has fallen is better revealed by comparison with her exports to the United States in 1910, which amounted to 203,290,307 lb., which makes the present output only 23% of what it had attained under better political conditions.

Production of Spelter in 1916

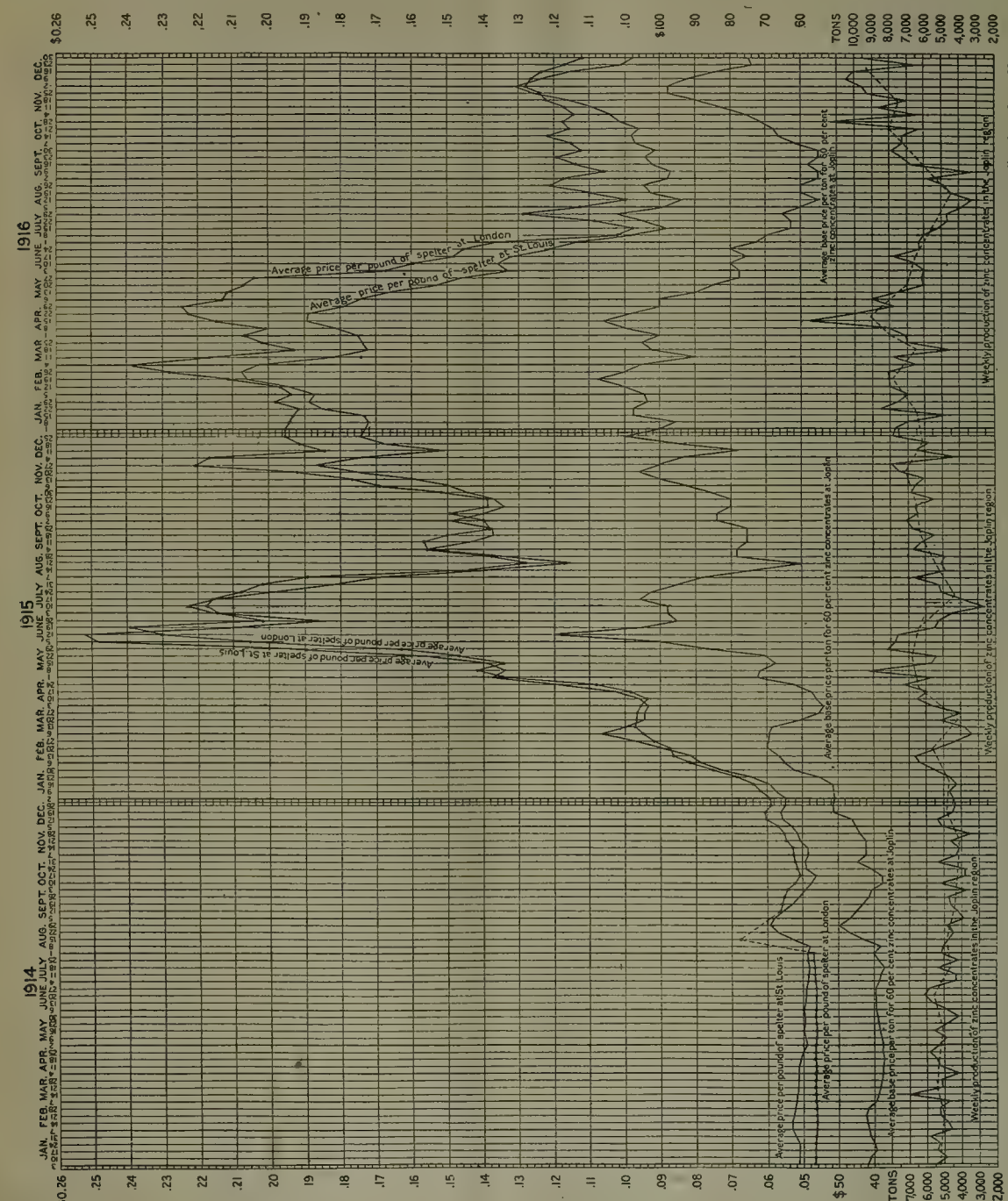
The significant feature of zinc production within the year has been the rapid development of electrolytic reduction. Starting from the experimental stage in 1915 it had reached the point where it was yielding at the rate of 40,000 tons, or 6% of the total spelter of the country, by the end of 1916, and the plants now building will have a capacity of 85,000 tons per annum. The most notable of the electrolytic plants is that of the Anaconda Copper Mining Co., which has reached an output of 100 tons per day, and will soon be ready to turn out double that amount. The statistics compiled by C. E. Siebenthal of the U. S. Geological Survey, accompanied by a chart showing diagrammatically the average prices and production for the year, which we reproduce on another page, reveal a total output of primary spelter of 667,456 short tons in 1916, being an increase of 37% over the previous year, or 92% above the production in 1913. The marked changes in our world relations brought about by the War, which will undoubtedly leave a profound impress upon the metallurgic activities of this country in the future, is shown by the importation last year of 385,964 tons of zinc ore containing 148,147 tons of the metal, whereas in 1914 the importation of zinc in ore amounted to no more than 12,132 tons. Of the imports, Australia furnished ore and concentrate having a zinc-content of 41,958 tons. The total number of retorts under heat at the end of 1916 was 219,418, as against 156,568 in the preceding year. The smelting capacity remained nearly stationary in Illinois, Kansas, and Missouri, the great increase being in Oklahoma and Pennsylvania. In Colorado, Arkansas, and West Virginia there was an actual decrease. The average annual capacity of a retort being about 4 tons, the existing potential output from retort-


1914
1915
1916
JAN FEB MAR APR MAY JUNE JULY AUG SEPT OCT NOV DEC
Average weekly price of lead at London
Average weekly price of lead at New York

Average weekly price of lead at New York and London, 1914–1916.

smelters would be 875,000 tons per year. Over 11,000 retorts were idle on December 31, while 13 new smelters were completed and construction on two more was started. Mr. Siebenthal calls attention to the rapidity and secrecy with which gas-fired smelters have been built in the South-west. In 1915 the average quoted price for prime Western spelter at St. Louis was 14.2c., while lower prices prevailed for future deliveries. The average quoted price in 1916 was 13.6c., and the average price received for spelter of all qualities, prime Western, brass-special, and high-grade, was 13.4c. The smaller difference between the quoted price for immediate delivery and the price received during the year was due apparently to an increase in domestic consumption, to a decrease in sales for future delivery, and to the production of a larger proportion of high-grade spelter.

Statistics of production of secondary zinc have not been fully available, due largely to the extraordinary


1914
1915
1916
JAN. FEB. MAR. APR. MAY JUNE JULY AUG. SEPT. OCT. NOV. DEC.
Average price per pound of spelter at St. Louis
Average price per pound of spelter at London
Average base price per ton for 60 per cent zinc concentrates at Joplin
Weekly production of zinc concentrates in the Joplin region
Average price per pound of spelter at St Louis
Average price per pound of spelter at London
Average base price per ton for 60 per cent zinc concentrates at Joplin
Weekly production of zinc concentrates in the Joplin region
Average price per pound of spelter at St. London
Average price per pound of spelter at St. Louis
Average base price per ton for 60 per cent zinc concentrates at Joplin
Weekly production of zinc concentrates in the Joplin region
$0.26 .25 .24 .23 .22 .21 .20 .19 .18 .17 .16 .15 .14 13 .12 .11 .10 $100 90 80 70 60
$0.26 .25 .24 .23 .22 .21 .20 .19 .18 .17 .16 .15 .14 .13 .12 .11 .10 .09 .08 .07 .06 .05
$50 40
TONS 10,000 9,000 8,000 7,000 6,000 5,000 4,000 3,000 2,000
TONS 7,000 6,000 5,000 4,000 3,000 2,000

Average weekly price of spelter at St. Louis and London and of 60 per cent zinc concentrates at Joplin and weekly production (sales) of zinc concentrates in the Joplin region, 1914–1916. The broken line shows the weekly sales, averaged by months.

demand for scrap, dross, brass-melters' flue-dust, and other materials of this kind by collateral industries. Secondary spelter, re-distilled, aggregated 29,663 tons.

CONSUMPTION OF PRIMARY SPELTER

(Tons of 2000 lb.)

Supply:	1913	1914	1915	1916
Stock, January 1:				
In bonded warehouses..	48	.....	111	32
At smelters	4,474	40,659	19,984	14,221
Production:				
From domestic ore.....	337,252	343,418	458,135	563,451
From foreign ore.....	9,424	9,631	31,384	104,005
Imports	6,100	880	904	684
Total available.....	357,298	394,588	510,518	682,393
Withdrawn:				
Exports, foreign, from warehouse	6,027	5,580	12,776	43,230
Exports, foreign, under drawback	7,459	4,981	255	.....
Exports, domestic	7,783	64,807	118,603	163,137
Stock, December 31:				
In bonded warehouses ..	.....	111	32	90
At smelters	40,659	19,984	14,221	17,508
Total withdrawn	61,928	95,463	145,887	223,965
Apparent consumption..	295,370	299,125	365,438	458,428

The table on preceding page shows the consumption of primary spelter and the domestic and foreign movement of the metal, whereby the apparent domestic consumption is seen to be 458,428 tons.

St. Louis Meeting of the A. I. M. E.

In extending an invitation to the American Institute of Mining Engineers to meet in St. Louis next October, the St. Louis Section properly calls attention to the extraordinary mining and metallurgical attractions in the vicinity of that city, as follows:

"Perhaps few know that the South-east Missouri district, about 80 miles south of St. Louis, and to which a special trip is planned, is the largest lead district in the world. In 1913 the production of the world was 1,270,000 tons, the last world figures obtainable, and in that same year the production of the United States was 412,000 tons, of which south-eastern Missouri contributed 133,000 tons. In 1916 the production of the United States was over 600,000 tons, and that of south-eastern Missouri 184,000 tons, being 32% of the total. The ore occurs not in veins, but disseminated through a great bed of magnesian limestone, more than 400 ft. thick in places, and as mined carries an average of about 3% lead. It has taken nearly a generation to perfect the concentrating plants, and the managers do not consider them perfect yet. The ore is crushed and cleaned until the concentrate will run about 70% lead. Some interesting developments in flotation are in progress, and nearly one-tenth of the clean ore shipped to the smelters is produced by that method. The concentrate is smelted at plants situated at Herculaneum, Alton, and Collinsville, with a combined capacity of 250,000 tons of lead per annum. These smelters will all be visited on the occasion of the meeting. The uses of the lead are also interesting. Just now its tremendous importance as a war material overshadows the fact that probably half the product goes into the form of white lead and other kinds of paint. Much is used as anti-friction metal, and as pipe and sheet."

Electrolytic Zinc

*The complex-ore question has been an unsolved metallurgic problem for a generation. It is now practically solved. What under old conditions was waste has suddenly become valuable. Even if only 80% of the zinc in complex ores can be recovered successfully by the electrolytic process in its present state of development, the removal of this large percentage of a deleterious element from a complex ore will simplify the extraction of the remaining more valuable elements. Western metallurgists now estimate that they can treat the so-called complex ores by the new method, crediting to the process the value from the sale of silver, gold, copper, and lead, and producing zinc at a price that will compete with the retort-process under normal conditions. Even had the War not broken out when it did the electrolytic zinc process would still have been developed. The directors of the Anaconda Copper Mining Co. were so impressed with this belief that they authorized a series of experiments at large cost. These were concluded under the direction of Frederick Laist, and they constructed a plant that produced 10 tons of zinc per day and later increased this to a capacity of 35 tons. They then decided to build a modern plant close to the source of power, as this is the principal item of cost in the process, erecting the largest electrolytic zinc refinery in the world at Great Falls, Montana. The plant, as designed, will consist of five units. Late in December three units were in operation, producing 95 tons of metal per diem, assaying 99.92% zinc. The completed plant will have a capacity of 160 to 175 tons of zinc daily. During the experiments in the test-plant at Anaconda the process originally proposed by Laist and Frick was much simplified, consisting essentially of the following steps: first careful roasting of the concentrate at temperatures not exceeding 730° C.; dissolving the zinc, together with a little iron, by spent electrolyte in Pachuca tanks. A small amount of manganese di-oxide is added to oxidize the iron, which is then precipitated by powdered limestone, bringing down any arsenic or antimony that may be in solution. This is leached through Oliver filters, and the residue is sent to the blast-furnace, while the filtrate, containing only zinc sulphate, with a little cadmium and copper, is treated with zinc-dust and again filtered, the filtrate being the pure zinc-sulphate solution which is sent to the tank-room. The anodes are of pure lead and the cathodes of pure aluminum. Deposition goes on for 48 hours only, when the zinc is stripped from the cathode-sheets and melted into slabs.

*Abstract of paper by E. P. Mathewson, Bull. Can. Min. Inst.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

CRIPPLE CREEK, COLORADO

LARGE PRODUCTION BY LEADING MINES MAINTAINED.—NEW DEVELOPMENT AND INSTALLATIONS PROPOSED.

The production of the Cripple Creek mining district, for the month of April, amounted to 64,598 tons, with an average value of $14.55 per ton and a gross bullion value of $940,048. This ore was treated at the several plants as follows:

Plant and location	Tons treated	Average value	Gross value
Golden Cycle Mining & Reduction Co., Colorado City	30,000	$20.00	$600,000.00
Portland G. M. Co., Colorado Springs	9,158	18.09	165,648.22
Portland G. M. Co., Victor mill	21,000	1.96	31,160.00
Isabella Mines Co., Cripple Creek district	1,540	3.00	4,620.00
Worcester-Rubie, Bull Hill	400	2.80	1,120.00
Smelters, Pueblo and Denver	2,500	55.00	137,500.00
Total	64,598	$14.55	$940,048.22

Dividends of record amounting to $300,000 were distributed during the month of April by Cripple Creek mining companies. The dividends are as follows:

	Per share, cents	Dividend
Cresson Consolidated G. M. & M. Co. (Regular monthly dividend)	10	$120,000
Vindicator Consolidated G. M. Co. (Quarterly)	3	45,000
Golden Cycle M. & R. Co. (Monthly)	3	45,000
Portland Gold Mining Co. (Quarterly)	3	90,000

The dividends do not include those of the close corporations and leasing companies and partnerships. The Cresson Consolidated G. M. & M. Co. has paid dividends totaling $600,000 to date for the present year, and the Golden Cycle M. & M. Co. has paid stockholders $185,000 this year.

The Cripple Creek deep drainage tunnel was advanced 175 ft. during the month of April, only one shift being employed. The tunnel will shortly pass through the Little Edith claim of the Queen Gold Mining Co. (a close corporation controlled by J. T. Milliken, of St. Louis) into the property of the United Gold Mines Co., and thence into the Portland Gold Mining Co.'s property. A flow of 9000 gal. per minute is recorded at this time.

The Portland Gold Mining Co. is operating three mills. the Colorado Springs mill is treating 9158 tons monthly; the Victor mill is treating 21,000 tons. The second unit of 250 tons will be in operation at the Independence mill of this company by May 10. The 500-ft. level of the No. 1 shaft has been thrown open to lessee operators, the available ground being quickly taken and some of the leesees already are producing.

A powerful hoist and boiler have been installed at the Rose Nicol shaft of the Rose Nicol Gold Mining Co., under lease to the Camp Bird M. M. & D. Co. Deep development is progressing from the 1000-ft. level of the Portland No. 2 shaft and it should be in Rose Nicol property by the middle of May.

New machinery is being installed at the Wild Horse shaft of the United Gold Mines Co. preparatory to sinking from the 1275-ft. level to a total depth of 1600 ft. The Deadwood group of this company is being developed at depth by a lateral from the 1000-ft. level of the Lee shaft of the Isabella Mines Company.

The Acacia Gold Mining Co. is sinking the South Burns shaft. Ten cars of ore from that shaft and two from the North Burns shaft were shipped during April.

The controlling interest in the Free Coinage Gold Mining Co. was recently sold to Chicago parties and the new company, now in course of formation, expects to resume operations on this Bull Hill property about May 15, according to Denver advices.

The Auraria G. M. Co.'s Forest Queen mine is under lease to Edwin Gaylord, who is breaking ore of shipping-grade. A cave which occurred while the property was idle exposed many carloads of ore valued at $10 per ton. The Auraria company is a corporation of Denver, California, and Kentucky men.

The Granite Gold Mining Co. is constructing an aerial-tramway from the Dillon to the railroad yards in Victor. A heavy production—100 tons daily—was made during April, the ore being loaded out by team. It had an average value of $30. The Dead Pine, Upper Granite, and Monument claims of the Granite company were operated by lessees steadily during April.

The mill of the Vindicator G. M. Co., at the Golden Cycle mine, was turned over to the Minerals Separation Co. for alterations and it is understood it will be available to the company by the end of May.

Operations on the property of the Yellow Bird Gold Mining Co. were resumed on May 1, and the extensive development of this old producer is planned under superintendent Yoeckell.

Lessees of the Mountain Beauty Gold Mining Co., operating through the Specimen shaft, are mining and shipping $30 ore.

MANHATTAN, NEVADA

DEVELOPMENT OF THE MORNING GLORY MINE.—SOME NOTES OF THE GEOLOGY OF THE DISTRICT.

At the new Morning Glory shaft a depth of 40 ft. has been reached and it is expected by the management that ore soon will be found. A second shaft, sunk years ago, is down 70 ft. on what is thought by some to be the same vein as that being developed in the White Caps mine.

The ore from this shaft has all contained gold, running from a dollar or two up to $17 per ton. Arrangements are being made to sink this shaft deeper, as it is thought, from the appearance of the formation and knowledge of the geology of the district, that high-grade ore will be found below, perhaps within 50 ft. of the present bottom of the old shaft. There is about 1000 ft. of this ore-bearing limestone in the Morning Glory property, and the same length along a second similar stratum of limestone lying north of the first, the duplication being due to the folding and faulting characteristic of the district. In addition to these two possibilities of development, there is a third lime formation running south-east from the Manhattan Consolidated east end-line. This limestone is 300 ft. long in the Morning Glory ground. There is also another outcrop 700 ft. long in this claim where assays show the presence of low-grade ore, in which some stibnite may be seen in places.

The Consolidated company has stoped to the depth of 200 ft. up to the west end-line of the Morning Glory mine, though no development has been done on the latter at this point, notwithstanding the formation continues into Morning Glory ground. It is considered as one of the favorable places where payable ore may be found.

The main mineral-belt of Manhattan district covers both slopes of an anticlinal uplift, extending in an east-west direction across the Toquima range. A normal fault, with north dip, follows the direction of the axis of the anticline. This main fault is accompanied by diverging branches and smaller parallel displacements. These faults evidently ante-date the period of mineralization. There is a much larger number of cross-faults and fissures that extend in a north-south direction, the whole forming a complex system of block-faulting. The blocks between the several cross-faults have been tilted, either north or south, and there is usually observable considerable horizontal displacement, although the vertical movement is usually small. The cross-fractures generally have a steep west dip, and in the west part of the district these fractures are associated with ore deposition, with zones of fracture and mineralization 4 to 10 ft. wide. In the east part of the district the mineralization in the vicinity of these cross-fractures is much less pronounced, but the places where the system of smaller faults crossed the large east-west system have been demonstrated to be the points where orebodies are the most likely to occur. Some of this ore is high-grade.

THE CAVE IN THE ALASKA TREADWELL MINES THAT LET IN THE SEA

JUNEAU, ALASKA

DETAILS OF THE CAVING AND FLOODING OF THE GREAT ALASKA TREADWELL MINES.

The Juneau *Alaska Daily Empire*, of April 23, thus describes the flooding of the Alaska Treadwell mines on the night of April 21:

The Treadwell, Mexican, and 700 mines, on Douglas island, owned by the consolidated Treadwell companies, from whose workings 17,000,000 tons of ore has been mined during operations of more than 30 years, are today filled with water from the lowest levels to the tide-level. Fifteen million dollars is the estimated damage done, when, shortly after 11:30 o'clock last Saturday night, a cave-in on the filled-in beach between the 700 mill and the Bunkhouse No. 4 occurred and thousands of tons of water poured through the opening, caused by the break of a stope, into the three big mining properties. Within one hour every man, except possibly one, reached the surface and every level of the various mines was filled with water. Two of the company's houses, the Treadwell natatorium and the Treadwell fire hall, caught in the maelstrom caused by the cave-in and the rushing high-tide water, swung around and around, then disappeared into the hole, lost to view, even at low tide.

Shortly afterward the huge oil tank situated on the beach near the 700 mill collapsed and the steel frames were twisted like paper, and fluid, which half filled the tank, poured out and, being sucked down by the inrushing water, found its way through the various levels of the mine and emerged in the old Glory Hole, a thousand feet distant.

Today huge cracks in the earth extend from the 700 mill, up the hill to the old Glory Hole and down to the mess-house end on the baseball grounds. All those living in the houses on the hill moved out early yesterday afternoon when the cracks began to appear. Bunkhouse No. 4 is today out of plumb by six feet, ready to slide into the abyss. The clubhouse is also equally as much out of plumb, and all are conjecturing when the next slide will occur and how far its ravages will be felt.

The Ready Bullion mine is believed to be safe. Trickling of water started soon after the three larger mines were filled, but immediately men were placed at work and an immense concrete bulkhead was started as an additional brace to the one already in place, and this bulkhead today is holding.

Today there are approximately 1000 miners temporarily out of positions, although scores of these men are being used on the surface, protecting mills, shops, etc., and adjusting conditions either to expedite speedy dismantling of valuable machinery or in preparing for work which will insure the opening of the mines now filled with water. Operations today, outside of those above mentioned, include the Ready Bullion mine and mill, foundry, cyanide-plant, Treadwell store and warehouse, and all power plants, fully 500 men being employed in these operations.

Guards are stationed around all danger points and no one is allowed to come within 1000 to 1500 ft. of the places which are now in a precarious condition.

When the first rush of water was noticed Saturday night, warnings were immediately sent out and signals displayed through the various levels where miners were at work. The excellence of this 'safety first' system easily describes why, out of 350 men below the surface at the time, only one has been reported missing.

Today groups of miners, many with their families, are waiting anxiously for the next step, either to be made by the unseen power of water and earth, or a cessation of anxiety and the word from the company officials as to the next move to be made.

OATMAN, ARIZONA

THE UNITED EASTERN DEAL CONSUMMATED.—THE OLD MOSS MINE BEING UNWATERED.—HIGH-GRADE IN GOLD ORE.

The sale of the Big Jim mine to the United Eastern Mining Co. was ratified on April 24 at a stockholders' meeting held at Phoenix, Arizona, where over two-thirds of the capital stock was represented. Secretary Warmbath states that the office-work incident to distribution of United Eastern stock to stockholders of the Big Jim Gold Mining Co. will be finished this week and that the stock will be distributed the last of the week. Superintendent Keating, who remained in charge of the mine

during April at the request of superintendent Burgess of the United Eastern, was relieved of his duties May 1, and will commence work at the Bluebird for the Big Jim Consolidated, which succeeds Big Jim Gold. At the time United Eastern stock is distributed stockholders of Big Jim Gold also will receive share for share of Big Jim Consolidated.——W. H. Holcomb, of San Diego, representing a syndicate of St. Louis and West Virginia capitalists, is unwatering the old Moss mine, near the Colorado river. The shaft is 330 ft. deep and there are 1200 ft. of lateral workings on the 300-ft. level. The water stands to within 100 ft. of the collar of the shaft. A gasoline-hoist and bailer have been installed and actual bailing is progressing. It is anticipated that three weeks will be required to unwater the mine. The mineralized lode is 250 ft. wide and is said to average $9 per ton. On the dump is ore valued at $30,000. The mine is mortgaged to the First National Bank, of San Diego, for $65,000, including interest charges. The syndicate, Mr. Holcomb says, is prepared to pay this mortgage if the mine samples to their satisfaction. The Moss mine is five miles north of Oatman and has been worked at intervals for forty or fifty years. Rich streaks of ore were mined and the ore milled on the Colorado river, seven miles distant.——The Gold Ore winze is down 105 ft. below the 530-ft. level and in the richest ore yet developed. The vein is seven feet wide and half of it carries $1000 per ton, according to advices from the mine. The ore is identical in appearance with the Gold Road ore. In the Gold Road mine high-grade shoots, like this, frequently were encountered. J. F. McConnell, who with Joe Perrizo owned the United Eastern ground, has purchased large holdings in the company. A new shaft and a mill are planned for the near future. A. C. Werden, of Gold Road, is manager.

PORCUPINE, ONTARIO

PROBABLE CURTAILMENT IN OPERATIONS.—A LARGE FOREIGN ELEMENT PRESENT AMONG THE MINE WORKERS.—A STRIKE FEARED.

Despite the fact that Hollinger Consolidated, during 1916, made a net profit of approximately $3,000,000, and ore reserves are estimated at $33,000,000, there are rumors that production at this mine may be curtailed to permit increased development work. Efficient labor is difficult to secure, and as a consequence, costs show an upward trend.

During last week, Dominion Government officials were in the district and arranged for the taking of a census of the alien-labor employed here. It was discovered that about 70% of the mine workers were aliens, about 40% of them being alien enemies. The taking of the census and the compelling of all alien enemies to report at designated offices at regular intervals has served to allay much of the uneasiness that for some time has been apparent among these workers, and which it was generally feared, would lead to labor troubles, and perhaps to a strike. The union will hold its annual convention at Cobalt, on May 7, and until that time, and perhaps even later, it will not be known whether a demand for increased pay is to be made. The general outlook, however, is brighter than a week or so ago.

The mill at the Dome Mines is now running at only 60% capacity, and here, too, curtailment of production is likely. That development work at all the mines will be urged vigorously appears evident, that is, unless the company is forced to close down entirely, due to the unreasonable demands that the mine workers may make.

The McIntyre-Porcupine continues to attract much attention. The big orebody at the 1000-ft. level continues with the same width and value, having now been opened up nearly 1000 ft. long. The 600-ton mill at this property is treating 500 tons daily. The mill-heads are being maintained at around $11.80, and gold bullion is being produced at the rate of approximately $150,000 monthly.

BRITISH COLUMBIA

SOME OF THE MORE IMPORTANT MINES OF THE WINDERMERE MINING DIVISION.—NEW DEVELOPMENT AND ORE SHIPMENTS.

The Windermere Mining Division is situated in the southeast part of British Columbia. The Golden Mining Division lies on the north, Alberta on the east, Fort Steele Mining Division on the south, and Ainsworth Mining Division on the west. It has an area of approximately 5500 square miles. Upper Columbia lake, the source of the Columbia river, lies near the southern boundary of the division. The Kootenay Central railway furnishes transportation for the Division, and runs from Golden on the main line of the Canadian Pacific south to the Crows Nest Pass branch.

Prospecting for mineral in the division has been almost wholly confined to the Selkirk range, west of the Columbia river, and the lakes between Findlay creek and its tributaries, and Salmon river and its tributaries. The area is about 48 miles long, north and south, and 25 miles wide, east and west. The prospecting thus far done has not been very thorough, but the veins discovered are remarkable for their strength and continuity. Much of the area is still a virgin field to the prospector. Some of the mines that have been developed in the Windermere Division are the following:

The Paradise mine is situated on Spring creek. It consists of a group of five claims, that were located in 1899. It had shipped up to 1904 about 2000 tons of ore that averaged 51.4 oz. silver and 59.3% lead. Between 1903 and 1916 the property was idle, but during 1916 R. Randolph Bruce, the manager, decided to re-open the mine, and since then 20 men have been employed and 20 teams have been required to haul the ore to the railroad. From October 1, 1916, to January 31, 1917, 1050 tons was shipped. The greater part of this ore contained 40 oz. of silver and 40% lead per ton. In the meanwhile a dump of 2000 tons of low-grade ore had accumulated, from which 200 tons was sorted out last fall and shipped. This ore ran 25 oz. silver and 25% lead. Much retimbering and cleaning-up was necessary in the old workings, and this has hampered work somewhat. Shipments at present approximate 150 tons per week. Within the past three months several new stopes have been started and some rich ore found. The vein has been followed down to the fourth level and the shoot is known to be 1000 ft. long. The ore carries both carbonate and sulphide of lead, with iron oxide, in a gangue of silicious lime. The enclosing formation comprises a series of shale, slate, and sandstone, intercallated with occasional beds of limestone. The ore is so desirable in lead-smelting that the Trail smelter makes a special rate on transportation and smelting-charge.

The Silver Belt group adjoins the Paradise property, and is owned by C. M. Keep of Washougal, Washington. The mine has been idle for many years. It is stated that in 1901 a shipment of 15 tons was made that averaged 218 oz. silver per ton. Last year a few cars of ore was shipped and it is now reported that work is to be resumed.

The Hot Punch mine, controlled by J. E. Stoddard, of Windermere, B. C., is on the north fork of Toby creek. Several hundred feet of development work has been done, and 50 tons of ore is on the dump ready for shipment. This ore averages 0.1 oz. gold, 49.3 oz. silver, and 38% lead per ton. The most westerly opening on the property is a shaft 90 ft. deep in which the vein is 1 to 3 ft. wide. The ore in this shaft averages 0.05 oz. gold, 39.2 oz. silver, and 66.6% lead. Another vein carrying high-grade ore was discovered on the property in 1916.

The Sitting Bull group at the head of Boulder creek comprises the Sitting Bull, Alice, Colorado, and Mary G. mines. In 1898 about $6000 was expended in development, but as the

holders of an option on the property could not get an extension of time work was discontinued. An option was taken on it in 1916 by the Sitting Bull Mining Co. and work was started late in that year. The early work consisted of a shaft 50 ft. deep, which produced some high-grade ore, several open-pits at various points along the vein, and a cross-cut adit. This latter is being driven to the vein. On the Mary G. claim the vein is exposed for 300 ft. and an adit has been run on the vein, which shows 20 in. of galena. In the Alice there is an 18-in. vein of high-grade galena. It is the intention of the company to develop the property and then to build a wagon-road from Horse Thief creek to the head of Boulder creek, where a gravity-tramway will connect with the mine.

The Isaac mine, owned by H. E. Forster, is on a small branch of No. 3 creek. The property comprises a group of four claims though all of the development is on the Isaac claim. The ore is taken to the head of the rawhide trail by a 1500-ft. aerial tramway. It is then packed in summer, or rawhided in winter, 3 miles to the wagon-road, and hauled in wagons 12 miles to Brisco, on the railroad. Four cars of ore was recently shipped which ran from 35 to 40 oz. silver and 35 to 65% lead per ton. Development will be continued during 1917 and large shipments will begin in the fall and continue throughout the winter. It is less expensive to rawhide ore along the trail on the snow than to pack it on animals.

The Lead Queen—a group of five claims—is situated on a tributary to No. 3 creek, and is owned by Thos. Brown and J. M. McLeod. The vein is from 2 to 4 ft. wide and can be traced through the five claims. Where developed, on the adit-level, it carries from 6 to 24 in. of solid galena and about 3 ft. of ore of lower grade. Ore is being shipped.

TORONTO, CANADA

THE LABOR TROUBLES CONTINUE IN SEVERAL DISTRICTS OF ONTARIO.—INCREASING OUTPUT IN IMPORTANT MINES.

The mining industries of northern Ontario are threatened with a serious disturbance over the labor question. There is a marked shortage of labor and a strong agitation for an all-round increase in wages of 50c. per day. By way of compromise, several of the Cobalt companies are now paying bonuses based on the selling-price of silver, which practically equal the demands of the men, but others have refused any concession, and the mine-owners decline to enter into any negotiations on the ground that this would involve a recognition of the Western Federation of Miners, with which the Union is affiliated. In the Porcupine and other gold districts the mine-owners are apparently determined to refuse any increase, stating that owing to the increased cost of material they are not in a position to pay higher wages and that skilled workers are already receiving as much as is asked for by the Union. According to a statement by P. A. Robbins, manager for the Hollinger Consolidated, the trouble is mainly due to the large foreign element, including many Austrians and Bulgarians who have been released from internment camps to work in the mines. These men, who have made good wages, have lately become slack and show a spirit of indifference and insubordination, and it is feared that serious trouble may break out at any time. The English-speaking workers are represented as being well satisfied with present conditions. Government officials last week took a census of the aliens employed in the mining districts, which is stated to have had a good effect in quieting down the unruly element. No decisive action on the part of the men is expected before May 7, when the mine workers will hold their annual convention at Cobalt.

The Hollinger Consolidated during the four-weekly period ended March 25, made a gross profit of $210,749, being $87,749 in excess of the dividend requirements, and reducing the deficit to $122,873. The ore treated averaged $8.67 to the ton and the working cost was $3.97. During the four-weeks period the sum of $82,963 was spent on new equipment.

Vein No. 58, on which spectacular ore was recently discovered, is holding out well. For 100 ft. the orebody averages $50 per ton, and is 14 ft. wide, with no sign of diminishing. The face of the vein is 400 ft. from the McIntyre boundary, which company is diamond-drilling to pick up the vein. The drill will explore a part of the McIntyre property that has not so far been prospected at depth.——The shaft on the Jupiter property is being sunk to the 1000-ft. level.——The cross-cut at the 600-ft. level of the Vipond-North Thompson has cut the vein at 50 ft. from the main shaft, where it is well mineralized. The mill is treating about 100 tons of ore daily.——The main vein of the West Dome Consolidated, which is being driven on at the 300-ft. level, has widened to 10 ft., assays showing increased gold content. The vein has been proved up by diamond-drilling for 2200 ft. and to a depth of from 600 to 700 ft. ——Material for the construction of an addition to the Schumacher mill is on the ground, but the work has been postponed owing to labor shortage. During March the production was valued at $20,000, and the expenses were $16,500; operating costs running $4.30 per ton. As the margin of profit is only about $1 per ton, operation may be curtailed in the event of labor troubles.——The Rypan, which has a property of 188 acres adjoining the Bewick-Moreing claims, is showing a number of promising veins and is preparing for development.—— At the Hollinger Reserve the vein is the full width of the shaft at 300 ft. and carries free gold. The shaft is being put down to the 400-ft. level.——Ralph Regnall has been appointed manager of the Dome Lake, in place of Harry Darling, who recently resigned.

The Temiskaming & Northern Ontario Railway Commission has appropriated $125,000 for the construction of a branch line from Swastika to Kirkland Lake, but construction may not proceed for some time.——At the Wright-Hargraves, in Kirkland Lake district, the vein, which is 12 ft. wide on the surface, has widened to 20 ft. on the 100-ft. level with a gold content reported at $50 to the ton.——A test-pit, sunk about 10 ft. on the Canadian Kirkland has yielded encouraging results, the ore in a 3-ft. vein showing free gold.——The first shipments of precipitate from the Teck-Hughes has been sent for treatment to the Buffalo mine refinery, which will handle the Teck-Hughes precipitate until arrangements can be made for its treatment at Kirkland Lake.

At the Nipissing, during March, ore was mined of the approximate value of $256,953 and bullion was shipped from Nipissing and from custom-ore of the estimated net value of $401,038. The report for the year 1916 shows profits of $2,028,866, as against $1,403,484 in 1915, and a balance available for dividends of $1,805,244. Upward of $193,000 was added to the surplus, which amounts to $1,980,126. The shipments for the year contained 3,819,768 oz. fine silver, valued at $1,980,126, and the total production of silver was 4,044,668 oz. of the net value of $2,955,062. The cost of production was 24.13c. per oz., as compared with 19.06c. in 1915. The ore reserves were estimated to have a value of 9,153,000 oz. silver.——The annual report of the Beaver Consolidated for the year ended February 28, showed earnings of $499,690 as against $351,124 for the preceding year. There was a balance on hand of $236,582, bringing the aggregate balance up to $639,821.——The Temiskaming is cross-cutting at the 1600-ft. level to reach the high-grade vein recently struck at that depth on the Beaver. The main shaft will be put down to 1800 ft.——The Coniagas is putting in additional tube-mills in order to increase the capacity of its flotation-plant to 500 tons per day. It is estimated that there are about 200,000 tons of slime and tailing to be re-treated containing from 3 to 6 oz. of silver per ton.

As a result of experimental work now being conducted at the Buffalo & Dominion Works by the inventor of the Holt-Dern process, the main objection to flotation in Cobalt seems about to be removed. Not only are experiments meeting with success in the treatment of flotation concentrate, but it would also appear that table-concentrate may be treated satisfactorily.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

The current production of the Kennecott Copper Co. of about 7,000,000 lb. per month from the Alaskan properties constitutes a normal yield for this time of year. Through the summer months operations wil speed up somewhat and the output may again equal the high figures of a year ago when for several months it ran above 10,000,000 lb. of copper.

Officials estimate that the current year will show fully as great production from Alaska as did 1916, or approximately 110,000,000 lb. Costs will be somewhat higher on account of the payment of higher wage bonuses. From the Beatson mine production now runs slightly better than 1,000,000 lb. per month, and by July the capacity should be sufficiently increased to permit of a yield closer to 2,000,000 lb. per month.

The work of doubling the capacity at the leaching-plant at the Bonanza mine should be finished during the next few months. This now has a capacity of close to 500 tons daily and will be increased to handle 1000 tons of tailing daily. The extraction from the Bonanza ore has been better than 90%; recovery from the tailing exceeds 70%.

Ore running 65% copper still figures prominently in shipments from the Bonanza mine. This, along with concentrate and precipitate, goes to the Tacoma smelter of the American Smelting & Refining Company.

ARIZONA

Gila County

The Arizona Commercial Co. with mines near Globe is increasing its output. The production in April was about the same as that in March, but in May it is expected to be well over 500,000 lb. It is thought 6000 tons will be treated and that soon as much as 700,000 lb. will be produced monthly. On the 8th level it is reported that the orebody is 45 ft. wide, of which 40 ft. averages 4% copper, and 5 ft. next to the hanging wall carries 9%. The 10th level is developing well, 80 tons of 11% ore having been mined there daily of late.

Mohave County

It is reported that rich ore has been found in the Diamond Joe mine in Cedar district, near the McCracken mine. An adit is being driven on the vein, which is getting wider as the work progresses.

The development of a molybdenite prospect in the Hualpai mountains, 15 miles east of Kingman, is in progress. The property is known as the Jackman mine. The ore is described as similar to that in the Leviathan, in the same district, but carries less copper.

Development is progressing with good results at the McCracken, where a large amount of silver-lead ore is being developed.

A new mining district has been formed 25 miles west of chloride, to be known as the Weaver district. The necessary steps for the formal creation of this new district were taken by 40 property owners there. It is composed of the two old districts, the Weaver and Minnesota. There are said to be many good prospects in the region.

CALIFORNIA

The State oil and gas supervisor, R. P. McLaughlin, states that the amount of crude oil stored in California is only about two-thirds of the amount on hand two years ago. This condition exists notwithstanding the fact that there are now more wells producing than at any previous time, and new wells are being drilled at a rate seldom exceeded in the past. Such a condition is worthy of serious consideration at the present time, in view of the dependence of many of our industries upon fuel-oil.

Development during the week ended April 28, as shown by reports made to the State Mining Bureau, shows no cessation in efforts to increase the production of oil. There are twenty-one new wells commenced, making a total of 372 since the first of the year, against only 216 during the same period last year. About the same rate of increase is noted in the work of deepening or re-drilling wells, the weekly report showing twenty-seven such jobs, making a total of 276 since the first of the year, as compared with 166 at the same date last year. A scarcity of casing is causing many old wells to be abandoned and second-hand casing is going into the construction of many new wells.

Amador County

James Giambruno, secretary of the Mother Lode Miners' Union, announces the secession of that organization from the Western Federation of Miners, on the ground of dissatisfaction with the parent union during the strike of last fall. Giambruno says the local branch of 800 members has paid in $5000 in assessments to the parent organization and that during the strike, the local workers received nothing from the Western Federation of Miners. A district union will be formed, to include the miners of Amador, Calaveras, and Tuolumne counties.

Calaveras County

(Special Correspondence.)—The mill at the Mokelumne group of mines, controlling interest of which is held by Max Müller, of Los Angeles, is running one shift on ore from the West-adit stopes on the Easzy Bird claim. The mill is a Joshua Hendy 100-ton ball-mill, having a ball-charge of 6000 lb. It is the best-equipped mill in this district. Mr. Gleason, formerly at the Plymouth Consolidated mine, in Amador county, is mill-foreman. Sinking is in progress, the shaft being down 100 ft., and a cross-cut is being run. The ore-shoots are all in the east and west veins. Good ore is found at the bottom of the shaft, but just how much has not been given out. S. Titus, formerly of Silver City, New Mexico, is foreman, and Mr. Howett, also of New Mexico, is superintendent.

The company operating the Safe-Deposit gravel mine, situated about a mile from Mokelumne Hill, has constructed debris-dams in first-class shape, having spent $20,000 in this work. Mr. Burgess, the superintendent, says he is now ready to begin operations. It was a paying property in the past.

The Boston mine, situated a mile below the Mokelumne group, is about to begin operations once more, having been closed down for 13 years. Probably 100 men will be working shortly. It is now owned by Sam Davidson, of Mokelumne Hill.

At the Maypole quartz mine, half a mile from town, the adit is in 300 ft. and driving to catch an ore-shoot cut at the bottom of an old shaft sunk in the early days. Some very rich ore was milled from the shaft that is now being re-timbered.

At the Lucas mine, about ¾ mile from the Mokelumne group, ore averaging $100 per ton has been found. It is free-milling. There is a good mill-site and a good head of water available. The vein averages 30 in. wide. Robert Irvine of Mokelumne Hill is the owner. The mine is being prospected

thoroughly. Antimony and tungsten have also been discovered recently in this vicinity and prospects for this district are now better than in many years.

Mokelumne Hill, April 28.

Dorroh and Cuneo have arranged with James V. Coleman for the right to work the tailing from the Angels mine, which has settled in China gulch since the mill was started, says the *Record*. Samples prove that the tailing carries sufficient value to pay, and a plant has been erected for the purpose of treating it.

This plant is in operation and consists of an Australian grinding-pan, or Freeman pan, as it is sometimes known, the first one to be put in operation in this country. It is driven by a 20-hp. gas-engine and is equipped with the usual amalgamating-plates and burlap-sluices for saving the fine sulphides.

The Australian grinding-pan is something new in grinding-devices on the Mother Lode and was manufactured at the Angels Iron Works, at Altaville, from plans and specifications by the inventor. W. J. Loring saw these machines in use in Australia and through him the Angels Iron Works has secured the American rights to the invention.

The pan consists of a heavy cast-iron bowl with vertical sides. It is about 5 ft. in diameter, 3 ft. deep, and lined on sides and bottom with cast-iron dies and liners. The muller is provided with wearing-shoes that are renewable. This muller makes 30 r.p.m. when used on thin pulp and may be run faster if conditions permit using less water. The fineness of the grinding is regulated by the discharge-pipe which may be moved in or out from the centre of the pan and the fineness of the product varied by so doing. A string of sluices has been placed in China gulch and the tailing is shoveled into them and is carried to a screen where the grass-roots, vegetation, and the larger stones are removed; the fine tailing then flows to the grinding-pan and when it has been ground sufficiently it flows over two amalgamating-plates, each 24 in. wide and 8 ft. long, and then over four burlap tables, each 18 in. wide and 8 ft. long, and is then discharged into the creek. The grinding-pan takes about eight horse-power to run it and it is said to have a capacity of 70 tons per day. Five men are employed at present.

Nevada County

When the first level of the Allison Ranch mine had been unwatered it was found that an 18-in. vein was exposed in the face of the drift. This level will be cleaned out and retimbered and exploration commenced. The water is going down in the shaft at the rate of 20 ft. daily, though the time that will be required to unwater the several levels will depend on the extent of the old workings, and also on the amount of water coming in, which will increase somewhat with greater depth, and until the zone of saturation has been drained.

Seventeen miners of Grass Valley have volunteered for military service and have left their homes for a training-camp. Nearly all of these men are said to be from the crew of the Empire mines.

San Benito County

The three furnaces of the New Idria Quicksilver Mining Co., which had been closed down for repairs, are again running and the output of metal is being increased. During April the output was a total of about 900 flasks, which is expected to be increased to 1000 flasks during May. New Idria is now earning at the rate of $6.50 per annum, and paying dividends of $1 per share quarterly.

San Bernardino County

At Goldstone two shifts are at work in the Goldstone company's mine. The property is well equipped with machinery, such as is required in the desert region. The shaft of the Double C. is being deepened. The Goldstone Mining Co. is about to begin work on the property it recently bought from the Redfield brothers.

Shasta County

Preparations are being made to sink a new shaft at the Stowell mine for the purpose of mining a new orebody that was discovered by diamond-drilling.

The new shaft will be sunk 300 ft. below the present workings to get well under the new orebody. During the sinking operations the shipping of ore from the mine to the Kennett smelter will be discontinued.

Trinity County

(Special Correspondence.)—The Gold Standard Consolidated Mines Co. of Oakland, California, has taken a bond on the Blair property, comprising five claims and situated nine miles west of Coffee, in the Salmon range, and has started development. The principal vein has an east-west strike, dips north 60°, and can be traced on the surface for 2000 ft. It shows a width of two feet at the bottom of a 55-ft. incline. The ore runs $24 per ton. A 232-ft. cross-cut adit cuts the vein 5 ft. wide, 165 ft. below the surface. The ore averages $36 per ton. In a 35-ft. drift, running east, samples go $97 per ton. The ore is free-milling. The foot-wall is porphyry and the hanging wall is schist. It is intended to build a 20-ton plant. There is an abundance of timber and water-power. J. R. Blair, of Weaverville, is the owner. The company holding the options is composed of Oakland men. Lincoln Brodt is president, Frank Driesbach, vice-president, and C. A. Munroe, secretary-treasurer. The deal was brought about by L. Grames of Coffee. William Briggs is in charge of the work.

Atkins, Kroll & Co., of San Francisco, has men at work testing the ground of the Carter & Williams hydraulic property on the North Fork of Coffee creek, on which they have a bond. Most of the work will be done with a self-shooter. Frank Rose is in charge.——Stuart & Phillips have a force working the Schlomberg hydraulic mine on the North Fork of Coffee creek. The mine is equipped with both a self-shooter and a pipe-line. Henry Carter is in charge.

Coffee, May 2.

Tuolumne County

At the Monarch gravel claim a milling-plant is being installed and will be in operation in about two weeks, says the *Democrat*. This property is situated on the South Fork of the Stanislaus river on the Hiatt place and shows a good prospect in the gravel of the ancient channel for which an adit is being run. Theodore DeMauris is the superintendent. The value of the gravel thus far uncovered is such that it can be washed at a good profit.

A station is being cut on the 800-ft. level of the Confidence mine, and everything is in readiness for starting the development work planned. It is proposed to sink the shaft another 800 ft. and explore the ground below the old levels. Fifteen men are working, but this force will be increased as soon as the conditions will permit.

The three-compartment shaft on the Yosemite mine, adjacent to the Rawhide, has reached a depth of 120 feet.

The F. J. Munn ranch property at Moccasin Creek has been leased by W. S. Fagan, J. A. McAllister, and L. L. Coffer, who will explore it for copper.

COLORADO

The road leading up to the Josephine mine, in West Argentine, has been cleared of snow, says the Georgetown *Courier*, and shipments of lead ore are about to begin for the season. Miners have been breaking ore throughout the winter and a large amount is stored in the mine.

The Wasach-Colorado Co. is working at full capacity, shipping ore to Idaho Springs. The Stevens mill is also running to its fullest capacity, treating ore for the company and from Stevens lease as well. New ground is being opened as fast as timber can be obtained to secure the workings.

The Hamill adit of the Philadelphia Mines & Tunnel Co. is believed to be nearing the Mendota vein, which it is thought passes through the property. The Mendota is employing a large force and is producing several hundred tons per month. There is much difficulty in securing experienced miners in the district.

LAKE COUNTY

Sinking at the Jamie Lee shaft of the Leadville Unit on Fryer hill, is progressing under favorable conditions. At a depth of 115 ft. below the old shaft bottom, a new pump-station has been cut in the white porphyry and machinery installed. The large water-course which has been causing so much trouble in the shaft has been intercepted by a drift from the new station and the water is being drained to the pumps. This project has made such a great change in the flow now entering the shaft that one small sinking-pump is able to keep the sump well drained.

The Jamie shaft is nearing the 670-ft. mark, 140 ft. having been gained since sinking was started.

The drill-hole that was being put down alongside the shaft has reached the Cambrian quartzite, having pierced the white lime. No important results are reported by H. S. Lee, the manager. A second hole is being put down in another place.

SAN JUAN COUNTY

The old Guston mine, near Silverton, again will be worked. Plans are well under way whereby lessees will operate this property during the coming summer. This mine is in the Red Mountain district and was an early-day producer of an immense tonnage of high-grade ore. It is said that several millions of dollars worth of ore was shipped from it during the early '90s.

After the slump of silver in 1893 the property was closed and has only been worked intermittently since that time.

SUMMIT COUNTY

The Gold Queen property at Kokomo, which was the scene of a rich strike several months ago, continues to produce high-grade silver ore according to late reports, says the Carbonate *Chronicle*. Last week two cars of high-grade ore were shipped from the property, the ore being reported as the best that has yet been extracted. It is stated that a large tonnage of the ore is blocked out and a larger output will be shipped during the summer.

TELLER COUNTY

Fred Sutherland, of Victor, is making good progress in the Llewellyn shaft and has already enlarged the first 50 ft. of the 230-ft. shaft, to two compartments. With the shaft enlarged and re-timbered, sinking will commence. The shaft is to be sunk approximately 500 ft. to correspond with the 600-ft. level at the Golden Cycle sixth level, from which the Excelsior Mining, Milling & Electric Co., holding a long-time lease on the Longfellow group, is now mining its ore.

Lessees working over the dump at the main shaft of the Requa Savage Gold Mining Co., on the north-east slope of Beacon hill, sent out a car of ore recently to the smelter.

An electric-hoist for installation at the shaft near the big open-pit of the Rex Gold Mining & Milling Co. on the south slope of Ironclad hill, has been hauled over from the Rubie mine on Bull hill. Thomas Kavanagh and associates are shortly to resume treatment at the Ironclad mill of the Rex company, and soon will be treating close to 100 tons daily of low-grade ore.

IDAHO

LEMHI COUNTY

An important strike of lead-silver-gold ore is reported to have been made in the old Yellow Jacket mine, 50 miles west of Salmon. This mine was discovered and worked extensively 30 years ago. At that time the mine was developed and equipped in what was considered an elaborate manner, but the management lacked experience. The orebodies were faulted and the character of the ore changed with increasing depth. Metallurgical knowledge was deficient and the whole enterprise lapsed into idleness. The 60-stamp mill, and other buildings, tramways, the water-systems, and all other equipment went to ruin. In addition to this a large amount of money was spent in a fruitless search for the faulted vein. From the original orebody a large amount of gold was produced, but the silver, lead, and copper were lost. The new strike of ore is considered as the most important development made in the Salmon district in 20 years.

SHOSHONE COUNTY

Search for an extension of the orebody that has yielded several millions of dollars to the Caledonia Mining Co. is the purpose of the Wardner Leasing Co., for which articles of incorporation have been filed at Wallace. The work of sinking a shaft to a depth of 400 ft. has been started. Mining men are interested in the operation because of the problem involved. This concerns the situation of an ore-shoot cut off by the Kellogg fault. The subject involved a geologic study at which W. A. Beaudry spent a year and a half. His deductions have satisfied others. The scene of operations is on the same side of the fault as the Bunker Hill & Sullivan mine.

Aside from the geological phase, Mr. Beaudry was confronted with a leasing problem. He was able to obtain concessions from the owners of more than 200 lots, but lacked the privilege of mining under the streets and alleys of the town of Wardner, which was not legally authorized to grant this privilege, so it became necessary to obtain the passage of special legislation at Boise permitting it do do so. The company has thus acquired the right to mine in an area equivalent to about four claims. The shaft is going down and will have attained the horizon of prospective exploration early in the summer, according to present expectations.

MISSOURI

JASPER COUNTY

For a consideration reported to be between $350,000 and $400,000, the St. Louis-Joplin Lead & Zinc Co. has sold its 400-acre tract of mining land in the Chitwood district to the Inter-State Royalty Company of Kansas City.

The Inter-State Royalty Co. is a $400,000 corporation made up principally of Kansas City investors. E. R. McClelland of that city is its president. He is also president of the St. Regis Lead & Zinc Co., which has the mine in operation on the tract purchased and also has an excellent sheet-ground mine at Duenweg.

Some promising strikes have been made lately in the southern edge of the Lawton-Waco field by W. W. Booth and R. D. McIntosh, of Joplin. Three holes have been put down and good ore encountered in each.

The drilling has been done on the W. G. Burgess farm, north of Carl Junction. In the first hole a run of only five feet of ore was found. The drillers moved off a short distance and tried again, and in this hole a rich run of 15 ft. of ore was struck. Another move was made and the ore face indicated by the cuttings was a full 20 ft. thick. Another hole has been started and if the good luck continues another mill-site will have been proved.

The ore-runs are found at comparatively shallow depth, and the formation is reported to be exceedingly promising, indicating that the same nature of deposits may be expected as are found a few miles to the north, where so many rich prospects recently have been developed.

MONTANA

MINERAL COUNTY

Four carloads of ore, two of them on Saturday last, have been shipped from the Intermountain mine, Iron mountain,

since the restoration of transportation facilities three weeks ago.

Five to six carloads of concentrated ore is awaiting shipment, and five to six carloads of crude ore is broken in the stopes. The concentrated ore has been settled for on a basis of about $2000 net to the carload. The crude ore is about 12% copper. Unwatering the 700-ft. level will begin soon after the receipt of a pump shipped from Chicago three weeks ago. A stope will be opened to the 700-ft. level.

Silver Bow County

The Anaconda Copper Co. has donated to the State of Montana the free use of 100 acres of irrigated land, and several thousand of non-irrigated for cultivation, to feed inmates of State institutions. The Butte Water Co., controlled by the Anaconda company, has offered free water to the people of Butte for gardening purposes.

NEVADA

Clark County

Concerning the operations of the Rand Mining Co. in El Dorado canyon, the *Miner* says: The mine and 10-stamp mill have been operating two shifts for some months past and at the same time the mill has been undergoing many improvements and additions to increase the output, as the large tonnage of ore reserve is increasing daily. The mill is equipped with amalgam plates and Wilfley tables. For the first two weeks of April the mill-heads carried a straight average of $27 per ton in gold with a small amount of silver. The highest grade ore put through the mill ran $50. The average of concentrate for the first 15 days of April was $400 per ton; the highest concentrate, $730 per ton. Shipments of ore were made to the reduction-works at Salt Lake City, which gave an average of $500 per ton, with the highest value at $2500 per ton.

In addition to the above the Lombard-Carnation and the Techatticup are running on good ore. The Techatticup is milling ore that runs from $20 to $25 per ton, and it is expected that the Lombard-Carnation will average nearly $40 for the next month or two, as an amount sufficient for a run of several months has already been mined and sampled.

The Colorado-Nevada company for seven months of 1916 showed an average of the mill-heads of $14.65 per ton. The orebody of the Colorado-Nevada varies from 10 to 32 ft. wide.

Nye County

Unwatering of the Union Amalgamated mine has been completed and a pump-station cut on the 600-ft. level. As soon as the pump is in position east and west cross-cuts will be extended in the orebody. The mill is running steadily on good ore from the upper levels. The property is controlled by Mushett & Wittenburg. Samuel Durkee is superintendent.

Sinking of the 200-ft. shaft of the Manhattan Consolidated to an approximate depth of 400 ft. has started with three shifts. At the 200-ft. point the vein is over 40 ft. wide and the shaft is expected to enter ore between the third and fourth levels. Mark Page is superintendent.——The Manhattan Uncle Sam Co. has been formed by William Darst and associates, of Venice, California, to work 75 acres adjoining the Portland and Annie Laurie properties.——Arrangements have been made for resumption of work on the Lucky group by Omar Maris.

The Crescent district, about two miles from Nipton, on the Los Angeles-Salt Lake railroad, is attracting considerable interest. James E. Keelyn, of Pasadena, California, has placed a hoist and compressor at the Keelyn silver-lead mine preparatory to sinking the 90-ft. shaft to considerable depth. At the 90-ft. point a 10-ft. vein of high-grade ore is exposed. The same company is operating a gold property in the district. Eastern people have acquired the old Toberg property and work has started under direction of William Hennessy. The Oro Fino, Sheerer, and other properties have been taken under option by representatives of Eastern capital. The district lies on the line of California and Nevada. Crescent is the nearest camp.

In the old Sweetwater district the Nevada Progressive Mining Co., composed of Chicago people, has arranged for a plant, with a capacity of 50 to 60 tons daily, at the Sweetwater group. Equipment will include a Denver quartz-mill, concentrators, and Koering cyanide-machinery. Shipments of silver-gold ore are being made to the Hazen sampler, assays average $59 to $108 per ton. J. S. Dawson, the manager, states that ore-reserves are placed at $300,000, with about $100,000 in shipping material on the dumps. The mine is well equipped.

The Atkins, Kroll Co. of San Francisco, has arranged to place its tungsten mines and plant in operation at Sodaville. Considerable work was done last summer and large deposits of ore were exposed, but the slump in the price of tungsten brought about suspension of activities in the fall. It is said 150 men will be employed.

Storey County

Whitman Symmes, superintendent in charge of the Combination shaft operations of the Middle Mines Association of the Comstock, says that on April 29 No. 1 pump at the shaft was placed in operation, and its first run showed excellent capacity. At the rate noted thus far, the pump will lower the water about 10 ft. per day. A second pump is being placed in readiness for lowering and use in the shaft as required. The levels long submerged are again to be opened for careful and thorough prospecting in ground that has never been opened, but which is believed to hold great possibilities.

Work is in progress on the 2900-ft. level of the Mexican mine on the Comstock for the first time since 1885, that level having been under water for 32 years. Ore broken in the Mexican below the 2700-ft. level last week averaged $59 per ton. Five bars of bullion was shipped, principally the result of Mexican operations. The Sierra Nevada continues to develop good ore on the 2450 and 2700-ft. levels. On the 2500 the north drift has been opened for 760 ft. and the face is approaching the east cross-cut where many years ago ore was found but not developed.

OKLAHOMA

Ottawa County

On the south 20 acres of its lease, near Century, the First National Mining Co. of Miami reports a drill-strike that is declared to equal any yet made in the field, says the Joplin *Globe*. A 25-ft. face of ore is indicated by the strike, and the cuttings are said to show an average assay for this face of 36.9% zinc.

The First National company already has developed a fine mill-site on the north 20-acre lease it owns, and a shaft at this point is down to ore. Another shaft has been started near the strike on the south tract, and construction of a new mill is to be started soon.

A fourth lease on 20 acres of land of the Lebanon Lead & Zinc Co. has been sold to the Red Bird Mining Co. for $40,000. The selling company still holds the third lease, and sold the fourth lease on the land at an increase in royalty of 5%. The Lebanon associates sank only seven drill-holes on the lease, but these showed good faces of ore at the 165 and 190-ft. levels. The upper level showed low-grade ore, but the lower level showed ore that averaged as high as 11.20% from the drill-cuttings. The new company will sink a shaft. It also plans the construction of a 300-ton mill.

UTAH

Sanpete County

R. E. Knowlden, president and manager of the Sanpete Central Mining Co., reports that he is about ready to ship the first car of ore. This is a new property and consists of 8 claims located six miles west of Ephraim.

The ore is both sulphide and chloride and occurs mostly along a lime and sandstone contact, and assays from the ore now on the dump ready for shipment give returns of 34 to 42% lead, with 3 to 5 oz. in silver. Another car, which is nearly ready for shipment, will average about 18% lead and some silver, and there is blocked out several tons of the high-grade ore.

It is estimated that there is over 20,000 tons of low-grade ore that will pay fair returns if treated in a mill at the mine, and the company has in contemplation the putting in of Deister-Overstrom tables, Harz jigs, and other necessary machinery.

It will require the installing of an 800-ft. tramway to bring the ore down to the road where the mill will be erected, also the piping of water about 6000 ft., and a small pumping-plant to get the water to the mill, unless water can be developed on the premises, which is likely, Mr. Knowlden says.

The force of men at the property will be increased as fast as development requires.

Associated with Mr. Knowlden in the property are Adelbert Anderson, Harley Myers, Neils Mortenson, Jr., Anton Anderson, J. F. McCafferty, John Dyring, Andreas Olson, Leo Stevenson, and Mrs. Jacobson.

WASHINGTON

Ferry County

(Special Correspondence.)—The Knob Hill Mining Co. is excavating for the housing and installation of machinery for its new shaft, the sinking of which, to a depth of 500 ft., will begin about May 10. A gasoline-hoist will be used for the present, to be replaced later with more powerful machinery. The machine-drills will be supplied with air from the compressor at the old works. The site chosen for this new shaft is just east of the portal of the lower main adit. Cross-cuts will be driven from the new shaft to the main vein and the spurs from it, below the present workings. The 500-ft. level of the new workings will be approximately 700 ft. below the cropping of the Knob Hill vein. The company is still maintaining shipments of a carload of ore a day. After paying a $10,000 dividend a reserve will be left of $27,000, in addition to which 18 carloads are at the smelters or in transit, and yet to be settled for.

A 100-ton concentrating-plant has been authorized by the Galena Hill Mining Co. for its mine at Rock Cut, in the Orient district.

Republic, April 20.

Stevens County

(Special Correspondence.)—Report says active operations will be resumed in May on the First Thought mine, in the Orient district.

It is reported that the Easter Sunday group of claims, situated between Orient and Northport, has been sold for $250,000.

In the Copper Butte mine, on Toulou mouutain, Orient district, 900 ft. in from the portal, stringers of copper ore are being passed through. Judging from the cropping, it is estimated that the main vein will be cut about 100 ft. farther in.

Orient, April 20.

NEW ZEALAND

The total production of minerals in New Zealand from January 1, 1853, to December 31, 1915, was valued at $510,162,461, of which $10,231,476 was accredited to 1915 production. Of the total, gold accounted for $411,941,745. There were 8361 persons employed in the mining of metals in New Zealand during 1915.

An extensive bed of scheelite has been discovered in the southern part of New Zealand. It promises to become one of the richest mines of the mineral in this part of the world. A syndicate has been formed to push its development. Tungsten ores are known to occur in several places in the islands, but none of them is of greater promise than this.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

T. A. Rickard is at Miami, Arizona.

John H. Eggers has gone to New Mexico.

Frederick W. Gay is back from New York.

Benjamin Rezas is again in San Francisco.

W. de L. Benedict has returned to New York.

Jacob W. Young has returned to State Creek, Alaska.

Algernon Del Mar was in San Francisco during the week.

A. Chester Beatty and family are touring in China and Japan.

J. Morgan Clements passed through San Francisco bound for Tokyo.

Stuart L. Rawlings is leaving San Francisco for Cerro de Pasco, Peru.

Ralph Regnall is manager of the Dome Lake mine, Ontario, Canada.

Philip N. Moore was in San Francisco and has gone to Spokane and Butte.

Bradley Stoughton passed through San Francisco on a tour of the Western States.

H. M. Wolflin has returned to San Francisco from the Mountain King mine in Mariposa county, California.

H. P. Gordan has gone to Alaska to take charge of the Alaska Handy Gold Mining Company's property on Chichagoff island.

Lieut. William Hague, engineer corps, U. S. R., has been ordered into active service at the Presidio training camp, San Francisco.

L. Webster Wickes is leaving Kingman, Arizona, to take charge of development of a copper property on the Ottawa river, Quebec.

Jay Louergan, who has been teaching mining engineering in the government university at Peking, is returning to America in May.

William Richards has gone from the Atolia mines to superintend the property of the Arizona Venture Mining Company in Mohave county, Arizona.

A. H. Babcock, consulting electrical engineer for the Southern Pacific company, has been commissioned major of engineers in the Reserve Corps of the Army.

William H. Landers, formerly manager of the New Almaden quicksilver mines, has entered the training camp for the Officers' Reserve Corps at Plattsburg, New York.

Obituary

William A. Farish, a pioneer mining man of California, who for years was associated with the late Senator George Hearst, died in Los Angeles on May 4, upon returning from a mining trip into Arizona. Mr. Farish came to California from Tennessee in 1852, where he joined his father, who was engaged in the wool business in San Francisco. He attended school in San Francisco and Marysville, later going to work in the Sierra Buttes mine, in Plumas county, California. While owner of the Monumental mine in Sierra county he took out one of the largest nuggets ever found in California. He was associated with Senator Hearst in the Black Hills of South Dakota and acted for him in the purchase of several important mining claims afterward included in the Homestake Consolidation. He had large personal interests in various parts of the West. Mr. Farish is survived by a widow, two sons, and a daughter.

THE METAL MARKET

METAL PRICES

San Francisco, May 8

Antimony, cents per pound	23
Electrolytic copper, cents per pound	37
Pig lead, cents per pound	9.75—10.75
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb.	$113
Spelter, cents per pound	12
Tin, cents per pound	58
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, May 8

Antimony, 50% metal, per unit	$1.60
Chrome, 40% and over, f.o.b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tungsten, 60% WO_3, per unit	20.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 45% (under 35% metal not desired), cents, unit.	36—38

Buyers of manganese ore transact business on a basis of the long ton of 2240 lb., for which the present price is $19 per ton for 45% ore. For each additional per cent 65c. is paid above the base rate, and the same deduction, of 65c., is made for each unit below 45%. Thus for an ore running 48% Mn the present price is $19 + $1.95 = $20.95, and an ore containing 42% Mn is worth $19 — $1.95 = $17.05. Ore running under 35% Mn is not wanted. A silica content up to 8% is permissible. A penalty of 50c. per unit is taxed on silica over 8%, up to 15%. If containing more than 15% the ore is not marketable.

Tungsten: On May 1 the new schedule for domestic tungsten ore came into operation and the Atolia Mining Co. is now quoting $20 per unit on the basis of 60% WO_3 with 30c. added for every unit above. Thus high-grade ore, running about 65%, would command a price of $21.50 and 70% as much as $23. Anticipating this advance of price, buyers rushed to contract before the new schedule came into operation and the month of April has probably seen the largest business ever done during any thirty days in tungsten. The quantity disposed of in the New York market reached close to 1000 tons and contracts were closed to cover every month of this year. Eighteen dollars was just as readily paid for November deliveries as it was for prompt material. At the present moment, no ore of known and reliable assay is available for immediate delivery. The quantities of foreign ore on the way to New York of known assay have already been sold while afloat. Foreign ore in New York is mainly composed of ore, which, on account of its impurities, is not readily salable and such ore is commanding a price of about $18 for prompt delivery. France and Italy have again appeared in our market as buyers for considerable quantities but have as yet not followed our advance, though the indications are that they will soon come into line again. The prospects of the tungsten market are exceedingly good and steady and it is anticipated that there will be a continuation of the prices now ruling for some time to come.

Manganese: The manganese position is unchanged. Buyers are anxious to pick up whatever lots are coming onto the market and to secure supplies contracts were entered into covering shipment for many months ahead. For 45% material 85c. would cover the present market quotation. Chemical ore, according to grade, is still quoted at 4½ to 6c. per lb. at New York.

EASTERN METAL MARKET

(By wire from New York)

May 8.—Copper is quiet but firmer at 31.50 to 32c. Lead is strong and higher at 10 to 10.25c. Spelter is steady at 9.37c. Platinum remains unchanged at $105 to $111.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending			
May	2	74.67	Mch.	27	72.06
"	3	75.12	Apr.	3	72.98
"	4	75.12	"	10	73.72
"	5	75.12	"	17	73.27
"	6 Sunday		"	24	74.08
"	7	74.75	May	1	74.06
"	8	74.75	"	8	74.92

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	72.51	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

Scantiness of supplies of silver has been indicated by the movements of the price recently. So long as demand, other than that which is continually in force for coinage, continued insignificant and fitful, the London market remained inert, especially as the China exchange was falling and sales from that quarter were fairly constant. A little more general inquiry set in on March 31, and was accompanied by improving rates from China, with the result that the quotation rose sharply ½ to 36⅛d.; a further rise of 5/16d. was recorded on April 2, and the higher level has been fairly well maintained. The slight reaction may be attributed to general clearing up before the holidays.

The United States government bought 400,000 oz. during that week. This may be followed by further purchases.

It is stated officially that purchases made by the Secretary of State, and also locally in India, since February 1916, sufficed to provide 36 crores (£24,000,000) of new rupees, a sum far exceeding the fresh coinage in any similar period since the re-commencement of the mintage of rupees 17 years ago. The total weight of silver represented is just under 123,500,000 oz., and, taking the average price of silver for the period (necessarily a rough method of calculation) the cost of purchase to the Indian government must have approximated £18,000,000, leaving a profit available for the Indian gold standard reserve of about £6,000,000. As the stock of silver in the currency reserve shows during the period a net decrease of over 4 crores, the amount of absorption exceeds 40 crores, an enormous sum, in about a year.

The last Indian currency returns show a moderate addition to the silver coin and bullion held in the reserve—the first time that this has occurred for three weeks.

The stock in Shanghai on March 31 consisted of about 30,600,000 oz. in cycee, and $16,400,000 on March 24, 1917.

An interesting announcement appeared recently in the 'Times' to the effect that owing to the rise in the price of silver, the Italian government is authorizing the issue of 1 and 2-lire notes to the nominal value of £12,000,000. The hoarding of silver currency is prohibited.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date			Average week ending		
May	2	31.00	Mch.	27	35.62
"	3	31.00	Apr.	3	34.58
"	4	31.25	"	10	33.83
"	5	31.50	"	17	32.75
"	6 Sunday		"	24	31.47
"	7	31.50	May	1	30.43
"	8	32.00	"	8	31.37

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.85	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	33.16	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

LEAD

Lead is quoted in cents per pound, New York delivery.

Date			Average week ending		
May	2	9.87	Mch.	27	9.50
"	3	9.87	Apr.	3	9.40
"	4	10.00	"	10	9.35
"	5	10.00	"	17	9.35
"	6 Sunday		"	24	9.43
"	7	10.00	May	1	9.62
"	8	10.25	"	8	9.93

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	9.38	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

On May 4, the Bunker Hill & Sullivan Mining & Concentrating Co. paid dividend No. 250, of $81,750. On the same day, the company paid an extra dividend, No. 251, of $81,750. These two dividends will make the total dividends paid to date $19,307,250.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound

Date			Average week ending		
May	2	9.50	Mch.	27	10.47
"	3	9.50	Apr.	3	10.71
"	4	9.37	"	10	10.64
"	5	9.37	"	17	9.87
"	6 Sunday		"	24	9.58
"	7	9.37	May	1	9.23
"	8	9.37	"	8	9.61

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.90	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	10.20	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date			Week ending		
Apr.	10	115.00	Apr.	24	113.00
"	17	115.00	May	1	113.00
			"	8	113.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	114.50	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	48.25	51.49	55.63	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Platinum is unchanged at $105 for soft unalloyed metal and $111 for the hard natural platinum-iridium alloy.

Eastern Metal Market

New York, May 2.

The question as to how much copper, lead, and zinc will be bought by the Government and by the Allies, and especially the price to be settled upon, are the controlling factors in the market which is generally a waiting one because of this uncertainty.

Copper, while still nominal and dull, had a spurt of activity last week.

Zinc also showed a renewal of interest and buying last week, but it is quiet again.

Lead is very strong and higher, with consumers doubtful as to whether there will be enough to go around after the Government has made its purchase.

Tin is unusually quiet but strong.

Antimony is easier and lower on larger supplies.

In the iron and steel market the Government's needs are also a dominating and deciding influence. At a meeting of steel makers on April 26 it developed that 610,000 tons of plates, shapes, and bars will be required for schedules already made up, while the year's requirements are estimated at 1,100,000 tons. The outstanding fact is that plans are shaping for purchases of iron and steel, copper, spelter, and lead by the United States government and the Allies in combination. It is believed, by informed persons, that prices will be paid which will maintain and not disturb present industrial conditions.

The April pig-iron output, according to telegraphic returns to *The Iron Age*, was the largest since October, having been 3,334,960 gross tons, or 111,165 tons per day, against 3,251,352 tons in March. The October rate was 113,189 tons per day. The present production-rate is close to 40,500,000 tons per year.

COPPER

The market continues in its normal rut. A show of life and strength manifested itself the middle of last week when inquiries were more numerous than for some time and some business was done. The cause of this condition was the report that the Government would pay not less than 25 to 26c. for any of its additional needs and that the Allies would pay the same or the market price for the last half, whatever that may be. This displaced some of the gloom and stagnation. At present the market is dull and nominal, and is a distinctly waiting one. Some large brokers believe that the Government will not pay a high price for the metal, and that, if it does, the same should hold true of other metals. It is understood that last week some unsold metal was offered at 26c. for the last half, with no takers. One large dealer yesterday quoted 26c. for third quarter delivery, but reported no business. The London quotation yesterday for spot electrolytic was £142, unchanged from last week.

LEAD

The lead market gains in strength as the days go by. The fact that the needs of the Government are to be very large indeed is fast becoming realized, though the actual figures are still a mystery. The market is difficult to describe. The question of the Government's needs has divided sentiment so that currents are crosswise. Some sellers declare that it is necessary to sell in order to prevent a runaway market. Others seem afraid to sell, deeming it their duty to fortify themselves so as to be able to provide a supply for the Government. The resulting condition is manifestly mixed and unsettled. It is conceded that the authorities will purchase a large amount. Some fear there will not be enough lead to go around. One net result has been a withdrawal from the market by some sellers, and more anxiety by some buyers. Purchases have been large, totaling 4000 to 5000 tons since this report was sent a week ago. The delivery involved has been principally for June and July. Spot lead was almost unobtainable at one time, and some sales were reported at 10c., St. Louis, for May metal. The quotation yesterday was 9.75c., St. Louis, or 9.87½c., New York, for early delivery.

TIN

It is believed that buyers are well covered for their immediate needs since they show no anxiety and remain more or less aloof from the market. The week as a whole has been dull and quiet, and during the last three days the market seems to have come to a standstill, sales having amounted to not more than 50 tons a day on those days. The month started yesterday with almost no sales. Spot metal was quoted at 58.50c., the range for the week having been between 58 and 59c., New York, sales at the latter figure having been made on April 27. On April 30 about 25 tons of Straits in transit from London was sold at 57.50c. It is believed stocks are low, as a preliminary estimate of stocks on landing April 30 puts this at 1707 tons, though arrivals from Pacific ports to the East will not be known until May 10. Tin deliveries in April from Atlantic ports were 3800 tons, about the same as those in March. Arrivals May 1 were 100 tons, with the quantity afloat 2812 tons, or unchanged from last week. The London market has advanced, the quotation yesterday having been £230 2s.6d., or nearly £6 over that of a week ago. The average price for tin for the month of April was 55.82c., New York.

ZINC

In sympathetic, as well as psychological, influence with events in the copper market, the zinc market woke up from its stagnation last week and for a time manifested more animation than for two or three months. Possessed of the belief that the Government would cover its war needs at market rather than sub-market prices, consumers realized that spelter was cheap. Sales of considerable proportions were made last Thursday and Friday, mostly for delivery this side of July 1. Galvanizers were prominent buyers, and other interests participated, as high as 9.50c., St. Louis, having been paid. This week the market is decidedly quiet and not much business is being done. The quotation is 9.25 to 9.50c., St. Louis, and not much further activity is expected until the Government's requirements and the price it is to pay are known. Awaiting developments is the slogan now for both sellers and buyers. The Government, in a preliminary statement, puts the March exports at 21,000 gross tons.

ANTIMONY

Arrivals of fair proportions of Chinese and Japanese metal overland from the West have decidedly eased the spot market, and this position is now quoted at 32 to 32.50c., New York. Considerable interest is shown in future shipments from the Orient.

ORES

TUNGSTEN. There has been heavy buying of concentrate reported in anticipation of the probable effect, on May 1, of the new quotation of the Atolia Mining Co. of $20 per unit for 60% ore, with 30c. added for every unit over this. An estimate places the quantity sold at nearly 1000 tons for delivery all through the year, and at prices less than the new quotation. On the new scale high-grade ores running 65% would be quoted at $21.50, and 70% ores at $23 per unit. Ferro-tungsten has also advanced logically, or in anticipation, to $2 to $2.15 per lb. of contained tungsten. Demand is good.

MOLYBDENUM. With very little new ore appearing the situation remains as it was a week ago.

ANTIMONY. The nominal quotation is $2.25 per unit, with the ore reported as quite scarce.

Company Reports

UTAH COPPER CO.

The twelfth annual report of the Utah Copper Co. for the year ended December 31, 1916, appears containing a large handsomely tinted panoramic view of the vast surficial steam-shovel workings of its great mine. It illustrates beautifully the successive benches, rising in steps of 30 to 40 ft., from the bottom of the canyons to the summit of the hill, a total difference in elevation of 1355 ft. There is also an elaborate contour-map showing the area of the company's property, and a cross-section indicating the various elevations and delineating the underground workings which comprise many thousand feet of levels and raises, with numerous bore-holes outlining the orebody.

The gross production of copper in concentrate, for the year, was 196,752,631 lb. The shipments of crude ore contained an additional 664,849 lb. After making smelter deductions the net production was 187,531,824 lb. In addition there was produced 47,648 oz. of gold, for which the company received $20 an ounce, and 461,596 oz. of silver, which was sold for 66.68c. per oz. The net cost of all the copper produced was 6.95c. per lb. (6.612c. the previous year). Had it not been for the increased cost of labor and taxation, the cost per pound would have shown a substantial decrease, instead of an increase. The net operating profit amounted to $33,747,739.50; dividends on investments and other income amounted to $5,990,935.86. The total income or net profit available for dividends, or for other capital purposes, therefore, was $39,738,675.36, or $24.46 per share. Dividends were paid during the year as follows: March 31, at the regular rate then existing of $1.50 per share and an extra dividend of $1; June 30, a regular dividend of $1.50 and an extra of $1.50 per share; September 30, a regular dividend of $1.50 and an extra of $1.50 per share; December 30, a dividend at the newly established rate of $2.50 per quarter, plus an extra of $1 per share. The surplus remaining after dividends were paid was $20,244,795.36. The total dividends paid to date aggregate $52,215,777.50. The outstanding stock of the company remains unchanged, namely, 1,624,490 shares.

During the year no underground work was done in the Porphyry mine, but drifts and raises to the extent of 2619 ft. were driven in the Sulphide mine. One churn-drill hole was deepened in the porphyry orebody, and nine additional holes were drilled, the total of this work being 6906 ft. The combined length of the 96 holes drilled from the beginning of the development of the property up to the end of 1916, was 54,662 ft., corresponding to an average depth of hole of 569 feet.

Previous to 1917 there had been developed in the property 424,524,258 tons of ore, averaging 1.415% copper, of which quantity 270,000,000 tons is classed as fully developed, and 154,524,258 tons as partly developed. Prior to January 1, 1917, there had been mined from the property a total of 54,678,700 tons of ore averaging 1.449% copper, therefore the total reserve remaining amounts to 369,845,558 tons, averaging 1.41% copper. The year's addition to the reported reserve was 34,524,258 tons, which is 25,530,258 tons in excess of the quantity mined during the year.

The total amount of cap-rock removed during the year was 5,911,455 cu. yd. Previous to 1917, the total area over which stripping operations had been conducted was 226.61 acres, and the area completely stripped was 111.58 acres. Smelting-ore to the extent of 18,026 tons was mined by underground methods in the Sulphide mine. This ore contained copper, lead, and zinc. All of the concentrating copper ore was mined by steam-shovels, at a cost of 28.12c. per ton, of which 7.5c. represents the apportional cost of stripping, and 0.38c. the charges for development. The actual direct cost of mining all the ore was 20.24c., as compared with 16.61c. during 1915, when the cost of labor and supplies was lower.

The equipment used in removing the cap-rock was increased by the addition of 50 standard-gauge, 30-yard all-steel air-dump cars. Other improvements at the mine consisted of extensions of the water-system supplying water to the locomotive and steam-shovel boilers; a few lodging-houses for employees, and a new compressor having a capacity of 3760 cu. ft. of free air per minute.

The total amount of ore milled at the Magna plant was 6,143,500 tons, and at the Arthur plant 4,850,500 tons, a total of 10,994,000 tons at the two plants. The Magna plant treated an average of 16,785 tons daily and at the Arthur plant, 13,253 tons daily. The average recovery at both plants was 62.34% of the assay value, but this low saving was due principally to the unusually large tonnage milled, and only in small part to the presence of unrecoverable carbonate. The normal capacity of the two plants is 20,000 tons daily, whereas during the year the average daily tonnage treated exceeded 30,000 tons. The cost of milling at Magna was 35.35c. per ton and at Arthur 40.94c. per ton, the average cost being 37.82c. The total gross production of copper contained in concentrate was 196,752,631 lb. and the average grade of the concentrate was 18.71% copper. The copper contained in the smelting-ore, which was shipped direct, was 664,849 pounds.

Total copper produced from all sources was 197,417,480 lb. The average cost per net pound of copper produced from concentrate, after making allowance for smelter deductions, and after crediting the precious-metal value and miscellaneous income in Utah, was 6.918 cents.

The new leaching-plant for oxidized ores is situated on the hillside, 1200 ft. south-east from the Magna mill. Construction work was started early in August, and all of the grading, as well as all of the concreting for six leaching-tanks, and part of the concreting for six additional ones, was completed before Christmas. It is estimated that the 12 tanks now being constructed will have a capacity of 3000 to 4000 tons daily. It is expected that they will be ready for operation early in the summer of 1917, but this depends on how rapidly the necessary equipment can be delivered. The plant is so situated that it can readily be enlarged to 10,000 tons per day. The material for which this plant is being constructed is the oxidized and partly oxidized cap-rock overlying the sulphide orebodies. The total estimated quantity of this material is 40,000,000 tons; about one-half of this quantity has been removed and is stored in stock-piles convenient for future recovery. The grade of this ore, so far as it can be determined pending actual leaching operations and sampling on a large scale, indicates an average copper content of 13 lb. per ton. Experiments extending over a period of years indicate that about 10 lb. per ton is soluble in dilute sulphuric acid, which is the lixiviation medium that will be used. These experiments also have demonstrated that about 9 lb. per ton can be actually recovered at a cost that probably will not exceed 9c. per lb. of copper recovered, and it may be considerably below that figure.

MYSORE GOLD MINING CO. (LTD.)

The annual report of the Mysore Gold Mining Co. (Ltd.) for the year ended December 31, 1916, shows that 305,845 tons of ore was milled during the year, from which was recovered by amalgamation, 164,145 oz. of gold, being an average of 10 dwt. 17 gr. of gold per ton. There was also treated 239,877 tons of tailing for a return of 26,724 oz. gold, an average of 2 dwt. 5 gr. per ton, and 193,748 tons of slime produced 25,650 oz. of gold, an average of 2 dwt. 16 gr. per ton. The total production was 216,519 oz. of bar gold, equivalent to 197,245 fine ounces, of a realized value of £836,743, 8s.6d. The total production of the Mysore company to date (since September 1884) has been 215,239.99 oz. of fine gold. Total dividends paid, £8,390,344, 2s.2d.

Book Reviews

NOTES ON MILITARY EXPLOSIVES. By Erasmus M. Weaver, Maj. Gen. U. S. A., Chief of Coast Artillery. Fourth edition. Pp. 328 + viii. Wiley & Sons, New York. For sale by the *Mining and Scientific Press*. Price, $3.25.

The author takes advantage of the exhaustion of the third edition of his well-known treatise to bring the work up to date by the inclusion of changes brought about by experience in the present European war. In his preface he says that the more important of these changes are the substitution of wood-pulp for cotton in the manufacture of nitro-cellulose explosives, and the fixation of the nitrogen of the air; that in general no new explosives have been introduced; that the field is limited to the nitro-cellulose series, the nitro-glycerine series, the nitro-benzene series, and the alkaline-metallic nitrate mixtures, singly or to a combination of two or more of these series with the others; that the great propellant explosive for guns continues to be nitro-cellulose alone, or in combination with nitro-glycerine; that the explosive for charging shells is definitely restricted to picric acid or its derivatives, and for submarine mines and torpedoes to tri-nitrotoluol (TNT), or to gun-cotton; that the old nitrate mixtures are limited to hand-grenades, rockets, and pyrotechnics.

To this edition has been added an essay by the Director of the Institute of Industrial Research, Washington, covering the basic chemical behavior of the four organic elements in all explosives.

Part I states briefly the fundamentals of chemistry, the more modern theories of the ultimate construction of matter being disposed of in a brief foot-note. Part II lists the various substances used in the manufacture of explosives and describes briefly their manufacture, their chemical and physical characteristics, and their actions. In part III the various explosives are classified for military purposes by their explosive phenomena, while in parts IV, V, and VI, the three principal classes of explosives are described in detail with respect to composition, manufacture, and behavior. Part VII treats of Service Tests, part VIII of storage of explosives, part IX of the handling of explosives, and part X of military demolitions.

In the appendices are tucked away some paragraphs of absorbing interest both to the professional student and to the lay seeker for information on this important subject. The Laboratory Notes are designed to start students by directing intelligent experimentation; the Government Rules for shipment of explosives have instructive value to all handlers of explosives; and the previously mentioned notes on the four organic elements contain also a description of the rôle played by the halogens, in gas-attacks, all of extraordinary interest at the present time. The chemistry of gas-bombs and gas-masks is briefly and clearly stated in untechnical language.

It is difficult to draw the line between those parts of the work most valuable to the scientist and to the soldier; for the thoughtful student-soldier will want to know all the brief theory herein set down, and the scientist should become interested in the practical handling and use of the finished product. Finally, the whole book is so simply and plainly written that even the general public may find much profit in a study of this work of an authority in the chemistry, manufacture, and practical handling in service of one of the most essential elements of warfare.—A. H. B.

DURING the last year large areas of land in Colorado, Utah, and Wyoming have been classified by the Department of the Interior as mineral land valuable for oil-shale. The lands so classified, except two small areas, one each in Colorado and Utah, which have been set aside as naval oil-shale reserves, are open to mineral entry under the mining laws of the United States and to non-mineral entry in accordance with the provisions of the Act of July 17, 1914, the oil-shale deposits when entries are made under this act being reserved for separate acquisition under the mineral-land laws. In Wyoming approximately 460,000 acres has been classified as oil-shale land, and none of it has been included in a naval oil-shale reserve. The area underlain by oil-shale in Colorado and Wyoming and a small area near Watson, Utah, are shown on maps contained in United States Geological Survey Bulletin 641-F, a copy of which may be obtained free on application to the Director, United States Geological Survey, Washington, D. C. The oil-shale area in Utah will be shown on maps to be included in a report on the last season's field-work in that State.

Recent Publications

OIL-SHALE IN NORTHWESTERN COLORADO AND ADJACENT AREAS. By Dean E. Winchester. Bulletin 641-F, being a part of Contributions to Economic Geology in 1916. Part II. Pp. 59. Ill. and maps.

ANTICLINES IN THE BLACKFEET INDIAN RESERVATION, MONTANA. By Eugene Sternberger. Bulletin No. 641-J, being a part of Contributions to Economic Geology in 1916. Part II. Pp. 24, with maps.

COALS IN THE AREA BETWEEN BON AIR AND CLIFTY, TENNESSEE. By Charles Butts. Bulletin No. 641-K, being a part of Contributions to Economic Geology in 1916. Part II. Pp. 3. One map.

BAKED SHALE AND SLAG FORMED BY THE BURNING OF COAL BEDS. By G. Sherburne Rogers. Professional Papers 108-A, being a part of Shorter Papers on Economic Geology in 1917. Pp. 10. Illustrated.

THE NEWINGTON MORAINE IN MAINE, NEW HAMPSHIRE, AND MASSACHUSETTS. By Frank J. Katz and Arthur Keith. Professional Paper No. 108-B, being a part of Shorter Contributions to Economic Geology in 1917. Pp. 18. Illustrated.

THE REEF-CORAL FAUNA OF CARRIZO CREEK, IMPERIAL COUNTY, CALIFORNIA, AND ITS SIGNIFICANCE. By Thomas Wayland Vaughn. Being part of Shorter Contributions to General Geology in 1916. Pp. 40. Illustrated.

Commercial Paragraphs

The SULLIVAN MACHINERY Co. has removed its office in Montreal to Toronto, Canada, at 37 Colborne street. Compressors and hammer-drills and their extra parts will be kept in stock there.

The SPRAY ENGINEERING Co., of Boston, Mass., has issued an interesting catalogue describing and illustrating the numerous spraying devices manufactured by that concern. It is known as Bulletin No. 501, and may be had on application.

J. G. Dawson, of Chicago, will commence immediately to remodel his mill near Sweetwater, Nevada. He has given the DENVER QUARTZ MILL & CRUSHER Co., of Denver, an order for some $4000 worth of new equipment to be delivered by May 1.

The INGERSOLL-RAND Co., 11 Broadway, New York, has recently issued two new catalogues as follows: Form 3311, 20 pages, 6 by 9, covering the Imperial Type X duplex steam-driven compressors suitable for general industrial application of compressed air. The catalogue gives tables of sizes and capacities, and is thoroughly illustrated to show the machine in detail. Form 8507, 40 pages, 6 by 9, covers the Little David pneumatic drills. An endless number of various types and models are shown, with recommendations as to the particular character of work for which they are adapted. Each tool is illustrated and the several tables give the sizes and capacity of each tool. Copies of the above bulletin free on request at nearest branch office.

Mining and Scientific Press

Edited by T. A. RICKARD

Volume 114
Number 20

SAN FRANCISCO, MAY 19, 1917

15 Cents per Copy
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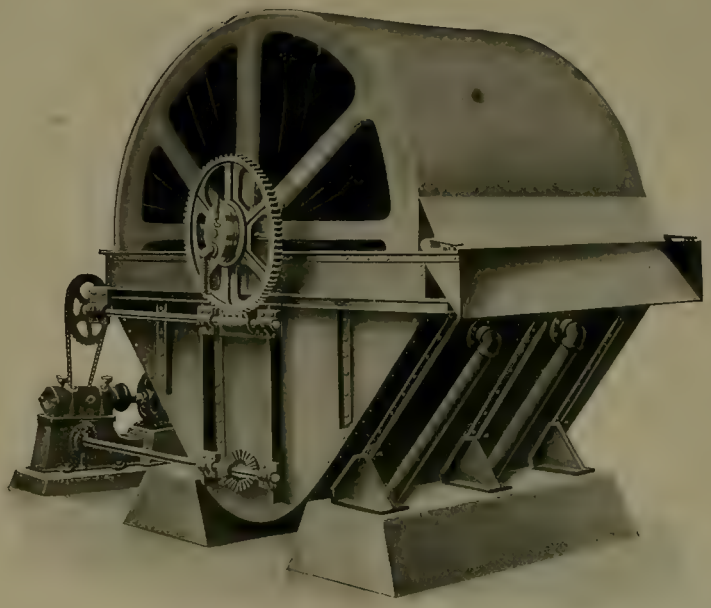
"Nothing but filters and filtration"



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W. H. STORMS - News Editor

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E. H. LESLIE
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Science has no enemy save the ignorant

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UNION CONSTRUCTION COMPANY

The Union Construction Page

UNION CONSTRUCTION COMPANY

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of
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EDITORIAL

T. A. RICKARD, Editor

COPPER is said to have been exported to Europe during the month of April in enormous excess over immediate requirements. This has been criticized as an effort to advance prices and stimulate share-quotations. Whatever the motive, the result proves to have been advantageous in view of the growing difficulties in shipping a sufficient quantity of other supplies.

AGRICULTURAL annexes to mines are proposed in a formal resolution by the Mining and Metallurgical Society of America. Once more does the stress of war reveal our wasted opportunities and demand reform. The amount of water thrown upon the desert from Western mines and mills, would, if properly used for irrigation, produce food for many thousands of men.

IN this issue we publish a chart for correcting tape-measurements up to 500 feet. This was prepared by Mr. Walter S. Weeks, of the University of California, at the request of several mining engineers, who had found useful his chart for distances up to 200 feet, published, with an explanation, in our issue of October 28, 1916. We feel sure that many of our readers will appreciate, as we do, Mr. Weeks' courtesy in preparing this second chart.

GRADUATES of technical schools are now offered the opportunity to obtain commissions in the Corps of Engineers of the United States Army, putting such recruits on an even footing with graduates of the Military Academy at West Point. This is altogether the most desirable branch of the service for men specially fitted for an engineering career, as it offers a field for continued usefulness and advancement in a wide range of construction work falling within the province of the Army. The rigidness of the competitive examination required for acceptance has been so reduced as to make it comparatively easy for any young technical graduate of fair accomplishments to secure a commission.

THE Massachusetts Institute of Technology has effected an arrangement for conducting future research-work for the United States Smelting, Refining & Mining Co. at the laboratories of that institution. The trustees point out that this step is in the direction of forming closer relationships between the great technical schools and the industrial world in preparation for the commercial war that is to follow the present clash at arms. The only comment that the case seems to merit is that such mobilization of the great laboratories, as an aid in the industrial struggle soon to be renewed, is wise and practical, and furthermore that it is another expression of a foregone conclusion among thinking men that the world is to gain nothing in rationalization of international industrial relationships as a result of the expiation of past errors in economic world-policy through the sacrifices now being made on the European battlefields.

COPIES of our issue of February 10 that were mailed to Europe went down on the 'Laconia' and the issue of February 24 appears also to have been the victim of submarine piracy. Incidentally, we may confess that our paper of October 9, 1915, or such copies of it as reached London, was confiscated by the British censor because we made a reference to the dropping of bombs on two buildings in London. We are glad to think, however, that we did no harm to the cause by our inadvertence.

IT is a phase of conservation, interesting if not new, that *The Daily Metal Reporter* credits to the Messrs. Guggenheim, a method of keeping in readiness to deliver lead to the Government. This consists in adding $10 per ton to the price of spot lead. It is a most excellent scheme; if a little less metal is sold the net earning capacity of the smelting concern remains approximately stationary—its dividends are conserved at an undiminished level; whereas, if sales persist in being active, the higher price for raw material merely becomes figured into the ultimate cost of many diverse supplies, where a single item is lost in the avalanche of figures. As indicated before, the method lacks novelty, except in being proposed as an aid to the nation in its present crisis.

LAST week we recorded the death of William A. Farish, the news coming too late for more extended appreciation of his character and notable achievements. Coming, as he did, to California in the days of its golden glory, his schooling in practical mining on the great Mother Lode fitted him to render distinguished services in the opening of the untouched mineral resources of the West. Thus it happened that this Tennessee boy soon became identified with the famous bonanzas that have helped make the history of a score of commonwealths, the Sierra Buttes and Monumental in California, from which latter Farish took the largest nugget found in California up to 1870; the Father de Smet and the greater Homestake in the Black Hills where he was instrumental in establishing that premier mining operation for the late Senator Hearst; the Fryer Hill at Leadville; the Head Centre at Tombstone; and the mines of Cripple Creek, the importance of which Farish promptly recognized,

resulting in recommendations to the Midland railroad that caused the extension of that line into the district. His activities touched every important mining camp in the West, and few men have been more widely known and esteemed as able pioneers in the development of our mineral resources. His brother, Mr. John B. Farish, whose name is intimately connected with the mining world, is now living in San Francisco.

PRESIDENT MOORE of the American Institute of Mining Engineers, addressing the May meeting of the San Francisco Section, urged that the question of raising the standard for admission to the Institute be given serious consideration. This has long been desired, and when a definite aim is set up a feasible means of attaining it can generally be found. The problem is not difficult when the officials express the sentiments of the rank and file, as we believe they will be found to have done in this instance. Mr. Moore's plan is simple and practical; he would merely raise the standard for the future. That would in no wise effect the status of the present members, nor would it introduce the jealousies of an aristocratic inner circle. It is in line with the spirit of growth and progress that means better adaptation to the purposes of a scientific association. No greater reason can be adduced for maintaining the wide-open door to membership that was offered when the Institute was founded than for holding the entrance requirements of a Western mining school at its pioneer level after the standards of culture and training had swept onward with a developing State.

INTENSIVE development of deposits of sulphide ore is urged by the Department of the Interior, for the sake of the incidental accumulation of larger resources of sulphur in the interior of the country. This is an important measure, and will doubtless stimulate sulphuric-acid companies that are not active bidders at present for mixed sulphide ores to enter the market. In no other way could a large demand for such complex ores be so quickly created as by utilizing the facilities existing at acid-plants, which could be made available for treating them with comparatively slight modifications or additions to the equipment already installed. This would encourage the development more particularly of complex ores containing abundant pyrite. Iron sulphide is difficult to separate from the accompanying minerals by selective flotation, but it gives the concentrate the necessary free-burning qualities for roasting in the ordinary Wedge and Herreshoff furnaces commonly used at sulphuric-acid plants. The tendency among acid-manufacturers during the last two years to resort to sulphur-burners, with the disadvantages incident upon using sulphur as compared with pyritic ore, accentuates the wisdom of such an expansion of the scope of operations of acid-making concerns in conjunction with the more energetic production of sulphide ores as proposed from considerations of military necessity by the authorities at Washington. The urgency of the situation is revealed by the fact that importations of pyrite from Spain have ceased, owing to lack of shipping facilities. The utilization of complex sulphides at acid-plants would assist materially in overcoming the difficulty.

The Building of Ships

Ships are to win the War, we are told. Most assuredly without ships in sufficient number we will not win it. Lord Eustace Percy of the British foreign trade department has affirmed that "if Prussianism is to be crushed, there must be ships, ships, and more ships," adding that the German submarines are sinking British tonnage faster than it can be turned out in British yards. In view of the contradictory statements that have been published regarding the intention of our Government to construct a thousand wooden vessels, it is our privilege to state that plans for a standard ship, which can be turned out wholesale after the fashion of building Ford automobiles, are nearly complete, representing a Herculean achievement considering the shortness of the time that has elapsed since the work of designing was undertaken. Meanwhile necessary materials have been secured lest they should be absorbed for other purposes, and assembly of these supplies at various points is being made. The equipment for motive power that could be provided within a proper time has already been investigated, and contracts let; there will be no delay in the delivery of this prime essential. A contract has been awarded to The Foundation Company of New York for a large number of these vessels having a displacement of 3500 tons each, and preparations for their construction are being made on Newark bay, under the direction of Mr. Franklin Remington. Similar preparations are under way at Portland, Oregon, and at Oakland, California. It is also understood that the Government has found an unexpectedly large supply of suitable air-dried timber available, so that the criticism of the plan, based on the scarcity of such structural material, proves to have been without foundation. Lake copper in large quantities will be rolled for properly sheathing the boats, which are to be built with a view to a life of 30 years. The amount of copper required for 1000 ships will be approximately 27,000,000 pounds, exclusive of copper fasteners, bolts, and rivets.

The labor question at first seemed to be a serious problem, but the decision to standardize the parts offers a means of overcoming the difficulty, as it is an easy matter to train carpenters to do piece-work following an unvarying pattern. The 15,000 expert ship-carpenters, working in conjunction with an army of other carpenters turning out special parts, will meet the necessities of the case. The objection offered in some quarters to the building of wooden ships on the ground that steel vessels could be constructed at practically the same speed, has been anticipated by enlisting every facility in the country for the construction of the normal modern type of merchantman, and by providing additional ways at the ship-yards as rapidly as possible for increasing the number that can be built simultaneously. It is stated that a

standard 5000-ton steel vessel, drawing 20 feet of water, has been adopted for this class of contribution to the urgent need of shipping. If not ready for service as quickly as the wooden ships, they will soon be available for supplementing losses by submarine attack, and those that survive the War will then be useful for trading to many South American ports where shallow draught offers an advantage on account of a common lack of deep harbors.

Criticism of the Government's plan to provide emergency ships is not justified at the present moment. They must be built, and that means, in this resourceful country, that they will be built. The evidence at hand indicates that no overwhelming difficulties have been encountered, and the work is in charge of Major General George W. Goethals who has won the confidence of the nation by doing big and difficult things in the past. He did not fail to build the Panama Canal on schedule time; neither will he fail to make ready the ships that the country needs.

Freedom of the Press

Censorship is a matter of concern in every department of life; it affects every industry. Censorship upon criticism will not, as some profess, remove obstructions to the free course of Government in effectively carrying out its programme; it will rather allow the sand and dirt to accumulate over the administrative machinery until the bearings are clogged and the hot-boxes bring trouble. If criticism be not exactly a lubricant, it is at least a most excellent besom to keep the works clean. We have welcomed a certain kind of censorship, but the politicians have gone after something wholly different. They have sought to muzzle the press; to surround authority with the halo of impeccability, which savors not of democracy. The argument of sensationalism has been used against the press to trick the public into acquiescence, and this, it must be confessed, is to attack the press at the spot where the linden leaf fell upon it. Nevertheless, the argument is one that confuses the issue. A considerable part of the American press has indeed become yellow, but the color has been given chiefly through the untrustworthiness of its news. Theory, opinion, criticism, have no power to harm when they contravene known facts. False argument cannot survive the truth if the truth be let out. It is when news that is offered as fact is actually a lie, that sensationalism leads the nation to error in thought and action. If the Government desire effective aid from an intelligent people its best endeavor might be directed toward means for making the press eager to obtain only truthful news, and this could readily be accomplished by creating a news-standard based upon a censorship that shall go no further than to put the seal of verification upon such dispatches as can be guaranteed by the censor to be true. If the public could be given assurance, both through the limitations set by the statute and because of the reliability of the censorship board, that the question of simple accuracy, untinctured by considerations of party policy, would govern the decision of the censor, every other dispatch lacking that guarantee would labor under the suspicion of being incorrect. To kill sensationalism, put an authoritative stamp of truth on that which is true, and it will automatically compel the newspapers to strive after a reputation for verity that shall make their own editorial sanction as valid as the official endorsement. A people fed on truth will think honestly; a people conceded the right to know all the truth excepting only those concerning bureaucratic plans and procedure that would give comfort to the enemy if divulged, will be a people certain to rally with enthusiasm to the support of the Government, and to give all that it has of brain-power and goodwill, of purse, labor, and life itself, in the high efficacy of deep moral conviction and devotion. A democracy kept in the dark, feeling that its news is censored not with a view to giving the truth but for the purpose of suppressing it, and perhaps of misleading by methods not wholly unlike those that have made the yellow press so reprehensible, is a people chained as is that people whom we have pledged to deliver from their autocrat.

We of the mining world deal with the facts of vital supplies that give sinews to the nation for fighting its battles; we disseminate knowledge of methods for winning the ores and for winning the metal out of the ores; it also becomes our obligation to take account of metal markets and of conditions that determine a just and patriotic distribution of the products of mine and smelter for the common good. If we may not speak the truth we then fail in our duty of aiding by information and suggestion in the co-ordinating of the mineral industries for national service. There is a right and a wrong use of censorship. It will be a disaster if anything more is attempted than to put the official fiat on news that is true, to leave it off if the item is not shown to be correct, to require the mark of approval to be printed with news that has passed muster, and to let the laws against treason take care of traitorous utterances. A strong government adds to its strength by enlisting the criticism of those used to the study of public affairs.

Labor in Mining

In this issue we publish an interview with a veteran of the profession, Henry C. Perkins, one of the engineers to achieve distinction in the period when Hamilton Smith and his friends were leaders in the business of gold mining. The mines in which he obtained his first experience, the Mariposa and the Almaden, are still active and the mention of them recalls the fact that many members of the profession served their apprenticeship at these famous properties. Mines are places where men as well as lodes are developed. New Almaden, more particularly, enabled Henry C. Perkins, Hennen Jennings, James B. Randol, Samuel B. Christy, Charles Butters, F. W. Bradley, and E. H. Benjamin to cut their wisdom teeth comparatively early in life. The quicksilver mines

made money for their owners, but even if they had not done so they would have declared human dividends of a kind that money does not measure. The engineering work done at the North Bloomfield represented a notable achievement of the early days; it included several miles of bedrock-adit, big dams, and long pipe-lines; it was all done at a moderate cost and so well that it compares favorably with similar work in more recent years. It is pleasant to read the tribute paid by Mr. Perkins to Hamilton Smith. The latter was not only an engineer of fine acumen and high character but by his association with the Rothschilds he helped to introduce many young Americans to a wider career than California by itself would have offered. It must be remembered that 40 years ago the mining industry of the United States was of small dimensions compared with what it is now, and an ambitious engineer was lucky to obtain an opportunity abroad. The El Callao mine, in Venezuela, furnished experience to a large number besides Mr. Perkins and Hamilton Smith; for example, there were Hennen Jennings, Thomas Mein, George Webber, and W. L. Austin. None of them learned more from his sojourn there than Mr. Perkins himself. He tells us two of the things he learned: that straight dealing is the best policy even with crooked people, and that human beings as workers are much the same the world over if they are given a chance. He does not say much about the 'bluffs' that he 'called' while he was manager of the El Callao, but we have heard how mining inspectors, governors, even Guzmán Blanco himself, found it useless to blackmail or bulldoze the quiet young American who attended strictly to his business and assumed that others would do likewise. Nothing is so disconcerting to South American indirection as North American directness. Concerning the labor question he has more to say, and it is highly interesting. His experience in California, Venezuela, Mexico, South Africa, and Korea, among the districts in which he supervised mining operations, appears to have furnished him with decided ideas on the subject. We accept them as coming from a man wise rather than smart, sagacious more than merely clever. To the younger men we commend the advice to employ the indigenous population of a mining district, teaching them and handling them sympathetically, instead of importing labor from outside, more particularly workmen that are foreign in race and speech. To take high-priced American labor to Korea or Rhodesia, for example, instead of training and teaching the natives of either country, is the kind of mistake that has been made often both by British and American mine-managers. The disregard of this fundamental idea, of making the most use of the indigenous population, was the basic objection to the importation of Chinese into the Transvaal. The system of indenture succeeded up to a point, but that point was not passed, because the experiment was ended summarily; but if the Chinese had stayed it would have given the Transvaal a hybrid population, and it would have delayed the development of the Kaffir as a mine-worker. Mr. Perkins put his idea to work in Korea, with notable success. He gives some comparative figures, suggesting that the rate of wages does not determine the cheapness of exploitation; on the contrary, the cheapest labor may prove the least economical. The comparison between the three mining districts of the Mysore, Korea, and the Rand is suggestive. To what extent a systematic effort has been made to educate the natives on the Kolar goldfield we do not know, but those Indian mines have been highly productive so long that any serious attempt to train the natives would have come to fruition by this time. In this district, as on the Rand, the employment of an excessive number of imported white supervisors is a heavy item of cost, and goes far to discount the effect of paying low wages to run-of-mine labor.

The first appointment obtained by Mr. Perkins was as a book-keeper. It is evident that his early experience in book-keeping proved of the greatest usefulness, because it gave him a keen realization of the fact that the profit of mining is dependent as much upon diminution of cost as increase of yield. The system of accounts in use at a number of important mines on the Western slope is based on the book-keeping developed by Mr. Perkins at the North Bloomfield and Alaska Treadwell mines. His own success as a mining engineer is largely due to his ability to analyze figures. Thus did an early training bear fruit in after years. The reference to sampling in Korea touches upon a controversial point, namely, to what extent regular sampling with a moil and hammer can be accepted as a decisive factor in estimating the prospects of a mine. Mr. Perkins found gold in patches distributed irregularly in a group of quartz veins. The workings were unsystematic and the rich spots had been gouged. He found it safest to appraise the mines by making an estimate of the yield of gold per square foot of vein on the supposition that the ore, when worked on a larger scale, would be extracted continuously and without selection. The bigger operations that he had in mind could not be based upon the hunting of pockets or patches. His forecast has been justified. The Oriental Consolidated has proved an important gold mine, the dividends aggregating $7,500,000. His remarks on the Japanese occupation are friendly and fair. We infer that new American enterprise in Korea will not have as much chance in the future as in the past. In another part of the interview he expresses a decided opinion that any advance in mining economy must come through an intelligent and sympathetic study of labor conditions, of the relation between employer and employee. He warns us against the continued raising of wages and suggests that the best results will be obtained by profit-sharing. This is good advice. In regard to the making of fortunes, speculation in shares, and publicity of company affairs, Mr. Perkins speaks with a sagacity that comes of keen observation and unbiased thinking. The older men have their own opinions and are not likely now to alter them, but we invite our younger readers to study the sayings of this distinguished veteran.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Amortization and Depreciation

The Editor:

Sir—In your issue of September 23, 1916, an article appears by Robert S. Lewis on this subject. Both the subject-matter and the article are interesting, and the issue raised is important. With regard to depreciation, much of what the author writes is sound, and I believe will be approved by nearly all competent men connected with mining. I cannot, however, agree with part of what he writes. With regard to amortization, I disagree almost entirely with the article. I write this to submit the way in which I see these matters.

With regard to the use of more or less complicated mathematical formulas to express either depreciation or amortization, I consider that these are unnecessary and unsuitable, at least in the case of nearly all metal-mining business. The premises on which the formula can be based are uncertain in varying degree—in many cases highly uncertain; in other words, the figures or estimates to which the formula must be applied are assumptions only, and in only a minority of cases will they prove to be even approximately correct. In passing, it appears to me that there is a tendency in some quarters to apply formulas to too great an extent in other mining work.

If we accept the view that sinking funds for return of capital and for depreciation ought to be created and, further, that the bases for adding to these ought to be determined ahead, that is, that in each case a certain number of years should beforehand be accepted as the period in which to accumulate certain agreed amounts and, again, that the periodical payments to the funds should be equal, then formulas are useful and even necessary. But I submit that the above view is not logical. The continually changing circumstances (including the purchasing power of money) make the said bases too rigid.

The use of formulas certainly costs nothing and can do no direct harm. I submit, however, that their use may tend to a wrong view being taken of the affairs to which they are applied, the tendency being to cause assumptions to be regarded as established facts. I submit that there are more logical, more elastic, and more business-like ways of dealing with these matters.

It appears to me that the question of amortization is essentially one for individual preference. It is right if those concerned elect to adopt it. That it has any other claim to being correct finance, I cannot see. A reason given is, that of the large number of stockholders in mining shares few understand the real nature of their income and provide accordingly. The reply to this is that it should be the business of the directors to see that the stockholders do understand the real nature of their incomes. It seems to me that it is just such matters for which they are appointed trustees by the stockholders.

In any case, amortization can only become a serious protection after a considerable number of years. During the early years, that constitute the most critical period for most mines, the protection is only incomplete and in varying degrees. It is claimed that some mining companies are practically amortizing their capital in order to prolong their lives, the end of their mines being in sight. This is not amortizing their capital. It is forming a reserve for the object specified. The use of the money so reserved in further mining (or other speculative business) is contrary to the idea of amortization, which is to retain intact the principal invested. As to whether the making of such a reserve for such a purpose is right or correct is again entirely a matter for those concerned. As to whether it is good business will depend entirely on circumstances and will be known only subsequently by results in each case. An abuse of such a practice is obvious. For instance, a board of directors, seeing the end of their fees in sight, would be tempted to use such a reserve in order to keep things going even if the prospects available to them at the time did not really justify the expenditure. It is not inferred that all boards would so act, but that the temptation would be there. In many cases a bias (conscious or unconscious) would exist and in some—let us hope a few only—no doubt there would be deliberate bias. It would not follow because a man invested in a certain mine that he would wish to have part of his returns therefrom used in such a way, and he would have a good right to object to it.

If it be decided in certain cases to establish such a fund, it would be more consistent and business-like not to fix a sum to be paid annually but to decide periodically what sum to allocate to the fund, all circumstances being considered. Presumably in such case if, as time went on, the mine showed promise of longer or shorter life, then the sum allocated on any one occasion would be smaller or larger respectively. Other changing factors would similarly be allowed for.

In cases where it is not desired to form such a fund, and if it be considered that many of the stockholders are ignorant of the real nature of their incomes, and that some protection should be given them on this score, I would suggest that the divisible profit (dividends)

should be paid in two lots, one to be regarded as income and one as return of capital. If stockholders thereafter regarded their total receipts as income they would certainly have no excuse for so doing. Personally, I do not believe that such action is necessary. Proper periodical explanations as to the real nature of dividends would, I consider, meet the case.

I submit then that amortization is not necessary to sound finance, and further that if it be decided by some to form a sinking-fund for the purpose either of keeping the invested capital intact at the finish of the mine or of prolonging the life of the company by securing new property, the logical way of dealing with the matter is not the application of rigid formulas, but rather the periodical appraisement of the situation and allocations based on judgment. The basis on which allocations are made are in most cases constantly changing. It is more suitable and logical that the alloctions should also be decided upon by periodical judgments.

Mr. Lewis allows that calculations on both amortization and depreciation are largely tentative and may require subsequent modification. It appears to me that he should carry the logical deductions further than he does. Obviously, for a mine to be profitable it must return the capital invested plus a suitable rate of interest during its life. This, however, in no way infers that the amount of capital should be treated in any specified manner. Nor can I see that amortization or a sinking fund is necessary for this fact to be generally understood.

That depreciation should be allowed for in calculating cost appears to me to be axiomatic. This is mainly because the wearing out of plant has a direct bearing on the future cost. If we suppose a mine in the working of which it was known that no replacement of plant would take place and no appreciable increase in cost of maintenance and repairs, then depreciation would not necessarily be a part of sound business. No such cases, of course, occur. Therefore depreciation should form a sinking fund against replacement and against future increase of maintenance and repairs as the plant wears out. Once the fund reaches dimensions sufficient to cover these requirements, it should cease to be further increased. To continue adding to the fund until at the finish of the mine it equals the full cost of the plant is simply equivalent to amortizing that portion of the capital which has been spent in plant. If any company elects to do this, there is nothing to be said about it. I claim merely that such a proceeding is not necessary to good finance. What appears to me to be sound business is that depreciation of plant should be written off so that future replacements and increased cost of maintenance should be distributed as fairly as feasible over the whole period of working. Less than this would certainly result in the cost tending to increase as time went on. This means that the cost during the earlier years, being smaller than can be maintained, gives a wrong impression of the capabilities of the mine as to profit-paying. Toward the finish of the mine's life, when it was reasonably certain that no further replacements would be made, it would be quite sound if those concerned preferred it, to distribute the fund accumulated for depreciation. Thereafter maintenance and repairs would keep the plant in condition.

Mr. Lewis says that "the replacing of several machines by one capable of doing the same work * * * , in short all expense necessary to keep the plant up-to-date and in proper operating condition, should be charged to depreciation, and not to capital." I think this requires amplifying. If such alterations mean installation that if effected at the beginning would have cost more than did the plant being altered or replaced, then the difference of cost is a fair charge to capital. It is the same as an extension of the plant, subsequently added to secure certain advantages in cost, tonnage, or extraction. The value of the replaced plant as it stands in the books (that is, its original cost less the amount written off in depreciation) less its selling-value is a correct charge to depreciation. Mr. Lewis in writing "all expenses, etc. * * *," probably means all expense over and above the usual work of "maintenance and repairs." The latter is an expense for the purpose of keeping the plant in proper operating condition. It could be included in depreciation. I think that few would consider this desirable. Certainly I do not. I consider that depreciation should not be used as a current working account but reserved for special work of replacement, including some of the bigger jobs of repairing.

Whatever may be the precise limits set to depreciation-accounts, it is generally agreed that it should be provided for. I submit, however, that the application of complicated formulas in arriving at allocations are inconsistent and liable to give the impression that the bases on which the allocations are calculated are certainties, which they are not.

Of the two forms of depreciation, physical and functional, the latter certainly depends upon an unknown factor, the future. Any provision made against it is mere guess-work based on general knowledge that from time to time new machines are invented or perfected that will replace existing ones. To apply formulas to allocations against such contingencies is entirely out of place. With regard to physical depreciation, we have something tangible to work on. We have experience with similar machines, and judgment can to some extent allow for the precise operating circumstances of particular machines. Even among the most favorable cases, however, it is rare that the factors are sufficiently certain to justify the use of complicated formulas.

In some industries, such as shipping and railways, the conditions may be sufficiently known. In long-established colliery districts and even in certain metal mines it may also be so. I submit that in the great bulk of metal mines it is not so. Changes and differences in metallurgical practice, changes and differences in character of ore (in depth or in different parts of the ore deposit), changes and differences in water, and even in climate, make formulas inapplicable.

Functional depreciation can be estimated only peri-

odically in the light of new factors which may have arisen since previous valuations. I submit that physical depreciation should be dealt with similarly, that is, it should be assessed periodically on the actual facts of the particular case and not by any formula or even rule-of-thumb. The points for consideration are, how long a life lies before it and what are the costs of maintenance going to be during that life. Such assessments made periodically will give the depreciation by differences. This can only be suitably done by those knowing the plant, or better even, by those actually using it. Of course, general experience as regards the average life of different machines is borne in mind.

In assessing functional depreciation, it is necessary to decide first on the manner of viewing it. If a machine has become obsolete, that is, if another machine has come into existence which would do work better and which would be installed in its place were the plant still to be erected, the logical issue would be: at what figure would it pay to continue using the existing machine as against a new one. That figure would be its value based on functional depreciation. Generally in such a case the value of the existing machine would be nil. There are cases where, while replacement would increase the profit, it would not increase it sufficiently to justify the cost of replacement. Frequently interruption to the work while the change was being made would form a heavier item for the replacement to repay than its own direct cost. In cases where, though a machine is obsolete, it would not pay to replace it, its value would be assessed merely at its selling-value (generally nil) or at its first cost less physical depreciation, according to the point of view. I would assess it on the latter basis, but would allow a larger depreciation than the purely physical one in view of its obsolescence, which has increased the probability of its being replaced in the future.

The application of functional depreciation in its entirety is open to difficulties. In cases where plant is replaced, the issue is clear. The replaced plant should be valued merely at its selling-value. Let us suppose, however, a whole treatment-plant that could be replaced by another, which would increase profits to such an extent that, while the change is not fully warranted, it would give additional profit rated at 75% of the book-value of the existing plant. Would it be advisable or correct therefore forthwith to write-down the plant by 75%? I think that most companies would decline to do so. Shortly, the application of functional depreciation in its entirety until such time as replacement is decided on, would be too full of complications and contentions to make its adoption desirable. Until actual replacement is decided upon, or at least foreseen, depreciation is suitably restricted to physical decay. An additonal allowance in view of obsolescence may, or may not, be made according to the circumstances.

Mr. Lewis is quite correct in his contention that reliance can be placed on the law of averages as instanced by the mortality-tables of insurance companies. That closely accurate average lives of different machines could be obtained, there is no doubt. What we want, however, in depreciation are the facts regarding a few machines and these, as he says, show a wide divergence from the average. He seems to me to come to the wrong deduction. The correct parallel would be whether, because averages can be reasonably relied on, a man would therefore be logical in assuming a certain life ahead of him or then, wishing to have accumulated a certain sum at date of his death, apply formulas to arrive at what sum he should periodically pay to a sinking fund for that object. This certainly would be unsound and would leave the very risks that insurance companies exist to eliminate. If insurance of plant against depreciation were feasible the law of averages would give the figures to work on. In calculating premiums in such cases formulas would be justified and necessary. It seems a pity that insurance against depreciation cannot be instituted. The premium it would place on careless use of plant would no doubt prohibit such being done. This applies to physical depreciation. Functional depreciation would be too open to disputes to permit of it.

In the above I have dealt with amortization and depreciation as applied to the creating of sinking funds, that is, to withholding of distribution of profits. From the point of view on the balance-sheets reflecting truly the actual value of assets, there is no doubt that at the end of a mine's life the plant should have been written-down to the selling-value of the plant at that date. This does not apply to amortization of capital. The value, at any date, of a mine does not depend on the capital invested. It depends upon the profit still to be won from the ore. The balance-sheet of a mining company does not give the actual value of all the assets. It does not do so with regard to the main thing—the ore deposit. However, it does purport to give the value of other assets, and I think it may be agreed that it should show the value of the plant at decreasing amounts, until, at the end of the mine's life, this shows only at its selling-value. Toward the end of a mine's life while depreciation was being written off the accounts, but not put into a sinking fund —not deducted from dividends—this would make it appear that that part of the distributed profit was payment out of capital. There seems no objection to this, as long as it does not masquerade as something else. Anyhow, the balance-sheet would show clearly that while certain profits are being paid the value of the assets is decreasing and any sensible person would recognize that to arrive at his true profit he must deduct his proportion of the decrease in value of assets. This comes back to a similar issue to that raised in connection with amortization of capital. If on the end being in sight and it being determined that no more replacements would be made, it were decided to distribute the amount lying in the depreciation sinking fund, this also would appear in the accounts as a payment from capital, similar to depreciation written off the assets but not deducted from dividends.

If it were considered unsuitable to thus make payments 'out of capital,' the case could be met by treating

the depreciation sinking fund as a suspense account.

In the above, amortization is discussed on its own merits alone. I agree, however, that the establishing of a sinking fund might serve, in the absence of other suitable or sufficient reserve, a most useful purpose. It would form a reserve that could be utilized, in case of need, to carry a mine over a critical period, such, for instance, as might be caused by a labor strike, by a sudden large increase in water, a caving or a fire in the mine, destruction of plant by fire, unforeseen difficulties with treatment or with plant. For this purpose, however, the fund would be useless in the early period of working, and it would become probably unnecessarily large in the later period. The use of the fund for such a purpose would be contrary to the idea of amortization. Still, it would be there as a real insurance, and could be diverted to such use if required.

I am of the opinion that a reserve should exist against such possibilities. There is, however, no consistency in forming such a reserve to start gradually with nothing and to accumulate by installments based on rule-of-thumb or on formula. It is often in the earliest period of working that such a reserve is needed. That period is not protected by the creating of a sinking fund. I submit that the consistent and business-like way of meeting the want is to provide for such a reserve in the initial capitalization. In some mines such reserve could be decreased after a period of working, when all the factors were better understood and conditions more settled. In others increased risks might appear and the amount be increased. In all cases the amount should be decided on the judgments of those best fitted to judge. In much of the older mining practice the function of such reserve was no doubt regarded as covered by the custom of calling up part of the capital only, leaving shares with liability for further payment. In modern practice this reserve seldom exists.

There are certain risks in mining that cannot be eliminated. There are others that can be. Among the latter is the risk of a mine being capable of paying satisfactory profits, but upset because of some unforeseen occurrence, which would not be fatal if a certain amount of money were available, but which without such may be fatal or very harmful. This is a risk that can be obviated in practically all cases, by the provision of a sum of money small in comparison with that spent on the actual development and equipment of the mine.

Amortization and depreciation, after all, are not matters vitally affecting the profitableness of a mine, whether they secure certain purposes of finance or not. A reserve such as described is a matter that may well affect the profitableness and even the very existence of a mine.

W. P. Sleeman.

Perth, Western Australia, February 17.

[This subject of Amortization and Depreciation goes to the base of mining economics. It is of universal interest and importance, and we shall be glad to have it discussed by others.—Editor.]

Misfires

The Editor:

Sir—May I add to this discussion of a subject far from unimportant, costing the mining industry a huge sum each year in lives, lost labor, and material. Misfires are always a serious problem to the miner in drift, stope, or shaft; he must find them, but not with a drill or pick first; later to bootleg them and lose part of a shift due to smoke and gas, or lose time mucking back when the lifters miss in the drift, or lose powder, shift, and all, because the cut-holes balked. Causes are easier to find than to apply the necessary remedies. The miner is often 'sot' in his ways, and when he bends his fuse sharply around a stick of powder, loading the primer muzzle-end first, there's a reason. He'd rather risk an occasional misfire than to risk withdrawing the fuse and cap with the tamping-stick, after putting the primer in correctly. He does not care to tamp in an upper where there is an exposed cap, and thus take advantage of the free use of the company's hospital. He can put the primer near the collar of the hole, but they might as well miss as to cut-off. I've been up against the trouble, and may say I'd rather search for missed holes that I had loaded than to hunt for the other fellow's misfires, and the following method will be found as good as any I have run across yet. A stick of powder has a wrapper folded at one end and crimped at the other. Take a 30-penny spike, or candlestick, and insert in the crimped end of the powder about three inches, making a hole in which the cap and fuse are inserted, then force in a small wooden plug, two inches long, alongside of the fuse and cap. This compresses the powder around the cap and fuse, so that it is difficult to withdraw the fuse. Next, if the primer is for an upper, split the cartridge in three places near the folded end, so that the cartridge can 'mushroom,' to keep it in place; there is then little chance of exposing a cap when the tamping-stick is withdrawn, while the cap is 'sighted' right and the fuse remains unbent. Try the plugs once and you are apt to keep plugging.

John A. Roos.

Ravalli, Montana, April 20.

Mine Samples as Baggage

The Editor:

Sir—May I suggest to Mr. Stanton that the use of a good strong trunk will solve his problem. It can be taken as far as the hotel at the town where he leaves the railroad and the canvas sacks placed in it when he gets back to town before it is taken to the station. I have been following this practice for a good many years and have never had any trouble. I agree with him about the advantage to the railroad in the encouragement of examinations by responsible engineers. I have no doubt if the matter was properly brought to their attention permission could be had, but I have never known of anyone who has gone to that trouble. Sometimes it is preferable to keep the samples at hand in a little leather bag.

Boston, April 5. Engineer.

THE CASA AT ALMADEN.

MAIN STREET IN ALMADEN.

Henry C. Perkins, and the Cost of Mining

AN INTERVIEW. By T. A. RICKARD

Mr. Perkins, where and when were you born?

On Staten island, New York, in 1846.

Where were you educated?

I attended schools in New York City, at Canaan, New Hampshire, at North Middleborough, Massachusetts, at Eagleswood, New Jersey, and finally I was a cadet at a military school on Staten island kept by M. Pujol, a Frenchman.

Did you have any special education for the mining profession?

I did not.

How did you chance to become connected with mining work?

When 17 years of age I was invited to accompany to California a cousin who had married Frederick Law Olmsted. Mr. Olmsted was general manager of the Mariposa Commercial & Mining Company, which was engaged in the development of the gold mines on the Mariposa Grant in Mariposa county. I was engaged in office work for the company when it ceased active mining in 1865.

What did you do then?

In October 1865 I entered the office of the New Almaden Quicksilver Mining Co. in San Francisco, where I served under the company's general manager, Samuel F. Butterworth, until 1870, first as assistant-accountant and then as accountant. At the same time I was secretary of a company that was mining borax and sulphur in Lake county. This company, by the way, I believe did the first mine dredging in California. The superintendent, C. W. Lightner, devised a bucket-dredge operated by hand-power. This was used to extract borax from Borax lake.

Where was your next work?

After a few months at New Almaden in charge of the office there, I went to North Bloomfield, in Nevada county, where as assistant to General A. M. Dobbie I became interested in testing the quality of the gravel in the ancient river-bed system. In 1871 Hamilton Smith was appointed manager of the North Bloomfield company and I became his assistant while he projected and started a bedrock tunnel to drain the deep channel. This tunnel was some 8000 ft. long in hard rock, and with the assistance of eight shafts the work was accomplished in less than three years by hand-work, excepting in the lower face where a diamond-drill was employed. The total cost of this tunnel was a little under $500,000. At the same time larger storage-reservoirs were constructed in the mountains, some 40 miles distant and the canals connecting them with the mine were enlarged and improved.

Was Hamilton Smith a trained engineer?

Yes, he had trained himself by practical work in his father's coal mines in Indiana.

He was a man of great natural capacity for engineering work?

Yes. He was a masterful character, he had a powerful intellect, a great grasp of the controlling factors in any undertaking, and a genius for thoroughness. The most important incident in my career was my association with him, which lasted until his death in 1900.

What was Mr. Smith's later work?

In 1874 he turned over to me the superintendency of the North Bloomfield company and moved to San Francisco, where he was elected president of the company. While there he brought Baron Edmond de Rothschild to inspect the hydraulic mines at North Bloomfield. Through this introduction he became the consulting

engineer for the Rothschilds in Paris and London. For them he first inspected and reported upon the El Callao mine in Venezuela and subsequently advised them upon their mining affairs generally. Hamilton Smith was instrumental in introducing abroad the greater number of those American mining engineers who have brought so much credit to the profession. His figure bulks largest among the mining engineers I have known.

How long did you remain at North Bloomfield?

I remained in charge of the North Bloomfield company's properties and also those of the Milton company until 1883, when the attacks of the farmers, assisted by the Federal government, against the hydraulic miners, who were charged with destroying farming land and injuring the rivers and harbors, became so harrassing and expensive that I saw that hydraulic mining in California would be no longer profitable, and I therefore accepted an offer to go to Venezuela, and assume charge of a valuable gold-quartz mining property there for a term of three years.

How long did you remain in Venezuela?

I managed the El Callao mine for four years, that is from 1883 until 1887.

This was your first experience in mine management in a foreign country and with alien races?

Yes, and I found my experience valuable. I learned two things that have been of great assistance to me.

These were?

First: I learned that a foreigner in a strange country, irrespective of the character of the people and its degree of civilization should assume that the great principles of right and justice do not vary with different races, nor with different degrees of civilization. Those principles are universal and ever-lasting, and they should govern our actions always—not only where and when they seem advantageous. My observations have brought me to the conclusion that disasters that come to us abroad in dealing with the authorities have been nearly always the result of our departure from those first principles, whether the departure was owing to ignorance, accident, or design.

Second: I came to the conclusion, which has been confirmed by my later experience, that the differences in the intellectual, moral, and physical qualities of people are not racial, but are owing to local influences to which communities are subjected by education, opportunity, temptation, and particularly by the impress of masterful characters. I believe that there is not 25% difference in the intellectual, moral, and physical value of the various races of the world when they are submitted to the same influencing factors.

In mining work is it possible to bring to bear upon the uneducated and semi-civilized races the influence you refer to in a reasonably short time?

My experience indicates that the time required is surprisingly short and I have concluded that when planning a long campaign of work, if the locality has an ample population, it is better to employ the local inhabitants in any kind of work, the simplest or most difficult, rather than to import labor from abroad. I make the proviso, however, that the effort must be made by those who are sympathetic with the race they employ, they must believe in the principle and they must have patience. These conclusions I have arrived at after a long experience in employing many races, white, black, and yellow for various kinds of work.

Probably not more than 10% of the individuals of any race is especially adapted by mental temperament and physical qualities to become very efficient in any particular task. Therefore to accumulate 100 of the most efficient workmen for any special employment, it will be necessary to select, by a process of elimination, this number out of 1000. For this reason an ample supply of men from which to choose is a highly important factor in securing the best results.

What is your opinion concerning the Chinese episode at Johannesburg?

I think it was a mistake; where an ample indigenous population is available it is better to train the natives for permanent work rather than to import foreign labor, although doing this may promise better immediate results. At the time the introduction of Chinese labor on the Rand was proposed I took this view, the reply was that an insufficient number of Kaffirs was available, a good reason if this had been a fact, which it was not as is now known.

Then you have come to the conclusion that in a long campaign of industrial effort it is best to employ the people of any populous neighborhood rather than to import labor from a distance whatever the race or prevailing state of civilization may be? If I am correctly informed, Mr. Perkins, you adopted the policy later when you were in Korea?

It would not be quite true to say that, because the policy was adopted by the men who preceded me. The policy had been forced by circumstances, but I accepted it and developed it sympathetically. When our company, the Oriental Consolidated, started working in Korea, the population in the neighborhood of the mine was almost exclusively agricultural, yet within three years the natives had learned to run the machinery, and were doing nearly all of the work of building mills, assaying ore, blacksmithing, as well as the underground mining. We have employed 5000 natives, with less than 60 white men, the latter chiefly in the accounting department, keeping tally of the stores, and handling and transporting the bullion. This number includes the manager and his staff. It suggests what can be done with an ignorant and entirely untrained people in a short time by making a sincere attempt to teach them how to be useful.

What was your experience in Venezuela?

In Venezuela we employed chiefly negroes from the West India islands, there being practically no local supply of labor. These negroes, whose only previous

THE NORTH BLOOMFIELD MINE.

training had been in agricultural work, for which they were paid about 25 cents per day, came to the mines and were paid $3 per day. They soon became expert in nearly all kinds of mining labor, and, after some improvement in organization, with these men we produced and reduced the ore from the gold veins nearly as cheaply per ton as they did at that time at the Mysore mines, in India, where the laborers received only some 20 cents per day. The mining difficulties so far as width of lode and hardness of ore were concerned were practically the same. My mining experience in Mexico justifies me in making the assertion that the mining cost there materially exceeds the cost in the United States, where the rate of wages is more than double.

Then you consider that the rate of wages is not an important factor in the cost of mining?

In certain cases it is an important factor, but I have come to the conclusion that usually its importance is much exaggerated. In estimating the value of a mining property I do not consider the rate of wages prevailing, however high or low it may be, as a vital consideration.

GELDENHUIS DEEP MINE, AT JOHANNESBURG.

As an illustration of the effect of the rate of wages upon the cost of mining I give the following table:

	Miners' wages	Cost per ton
Venezuela, in 1887	$3.20	$15.00
Mysore, in 1887	0.20	13.00
Alaska Treadwell	3.50 to 4.00	1.25
Mexico	0.50 to 0.75	4.50 to 5.50
California	3.00	2.50 to 3.00
Korea	0.25	2.50
Rand	0.75	4.00 to 5.00

In the Alaska Treadwell mine the great size of the deposit makes the conditions exceptional, otherwise I think the above comparison fairly indicates the singularly small effect that the rate of wages has upon mining costs. In India and on the Rand the unnecessarily large proportion of highly-paid foreign employees accounts materially for the high cost per ton in those localities.

Where did you go after leaving Venezuela?

I went to London and joined the firm of Smith & DeCrano. This firm had previously established the London Exploration company.

What work engaged your attention while a member of that firm?

I first examined gold mines in Mexico and later the Anaconda property in Montana. I then examined the Alaska Treadwell group of mines in Alaska and my firm purchased for the Exploration Company the control of these mines. I placed Capt. Thomas Mein, who had been my assistant in Venezuela, in charge of them.

After returning to London, Smith & DeCrano assumed the management of the London Exploration company and I established an office in that city for consulting work. I was appointed consulting engineer to the DeBeers Consolidated Mining Co., but this position was nominal, the direction of affairs being entirely in the hands of Gardner F. Williams.

How long did you remain in London?

For five years; until 1893 it continued to be my headquarters; in this period, however, I traveled extensively on mining examinations and undertook the development of a gold mine in Wales, which proved to be unprofitable.

Where else did you go?

In 1891 Lord Randolph Churchill decided to make a trip into Mashonaland, which in August of the previous year had been occupied by the British South Africa Company. Having been introduced to Lord Churchill by Lord Rothschild, I was invited to accompany the former as consulting engineer. Mashonaland was reported to contain valuable ore deposits.

How long did the trip take?

Some nine months, five of which were spent in Mashonaland and the remainder in traveling and observation in other mining districts.

What was your opinion of the mining prospects of Mashonaland?

I found gold widely distributed there and while at many places I saw rich ore, the veins and deposits were generally too small and irregular to justify a foreign company in undertaking their development.

Did you also visit the Matabele country?

No; at that time it was controlled by the Matabeles, who did not permit white men to explore for mines.

Then your trip into Mashonaland as a mining venture was a failure?

Not entirely so, for on my way up the country I visited Johannesburg and became much interested in that district now famous as the Rand.

What were the conditions of the mining industry in the Transvaal at that time?

The banket gold deposits discovered some five years previously had had their first period of development with the inevitable share boom, which had collapsed, the first expectations not having been fulfilled. At that time several of the companies had paid dividends, but none except the Robinson, the ore of which then yielded $40 per ton, had earned any actual profit, if the loss in scrapping inefficient plants were considered. In consequence the European investing public had largely lost its enthusiastic view of the value of these mines and the shares were much depressed in value.

You thought at that time that the profitable ore would persist into the untested ground on the dip of the conglomerate beds?

Yes. J. S. Curtis had previously advocated that view. It was obvious to anyone of mining experience. After looking over the situation I came to the conclusion that the district had a large intrinsic value, which would be demonstrated by improvements in methods, equipment, and management. I therefore took an active part in the development of the ground below the outcrop mines and after returning to London I interested large London and Paris financial houses in the mines of that district. In 1893, I was engaged by the firm of Wernher, Beit & Co. to manage the development of deep-level properties for a period of three years.

What sort of treatment did you get from the Boer government?

I thought that the government by the Boers was very good, considering the difficulties and temptations which the young nation was called upon to meet with so short a time for education in the new work suddenly imposed upon it. I saw no fair grounds for complaint except the oppressive dynamite monopoly and the difficulties thrown in the way of obtaining the franchise necessary to obtain any control over the taxes, which were almost entirely borne by the foreigners. This grievance, however, was rather academic than real, for the taxation was not excessive and few of the foreigners wished to become citizens, although naturally they chafed at the control over their persons and properties by an authority which many considered unfriendly.

The critical and hostile attitude of the foreigners toward the Boers and their government I thought was both irritating and unjust to them. This with the world-

SIFTING CINDERS AT A GOLD MINE IN INDIA.

wide unfortunate racial prejudice brought about that great tragedy, the Boer War.

You finished your term of three years on the Rand, and then?

I returned to Europe in 1896 and formed a partnership with Hamilton Smith. This association continued until his death in 1900.

What have you done since 1896?

I remained in Europe until 1898; in that year I returned to New York where Mr. Smith and I established an office where we cared for our various mining and other interests. In the following year I inspected mines in Korea, Siberia, Canada, and the United States, and in all of these regions I became interested in mining properties.

When you first went to Korea, in what condition were the mines?

A GROUP OF MEXICAN MINERS.

I went there with Leigh Hunt in 1900 and inspected the country 70 miles south-east of the Yalu river in north-western Korea. There was not much ore to be seen, and the gold was distributed in the quartz in a patchy way, making it difficult to estimate the available tonnage of ore. Mr. Hunt's company had done considerable development of the veins, extracting the rich ore wherever it was found. When I visited the property little good ore was in sight.

Did you sample the veins?

I did very little sampling. I mapped the work done by Mr. Hunt's company; an inspection of the maps showed that the ore had occurred in isolated spots and not in zones or shoots. After calculating that the yield of gold per square foot on the plane of the vein for the entire exploited ground had been $4 per square foot over the reduction cost, I came to the conclusion that these veins could be worked profitably if they persisted in length and depth, and as there were no indications of their early giving out, I decided the venture was a good one. I have often employed this method of appraising the value of a mine that is being worked. In other words, the question to be decideed usually is not what can be earneed by the working of some tons of ore, but will the aggregate yield of gold be greater than the aggregate cost.

The experience of the Oriental Consolidated Mining Company in Korea has been interesting and instructive?

This company gained possession in 1897 of the mining rights on a concession in north-western Korea covering some 400 square miles of territory. Scattered indiscriminately over the area were many quartz veins carrying gold, in granite; the veins were generally small, the largest being rarely over 6 ft. in width. The ore was refractory, carrying a large proportion of the base metals.

The population in this locality was devoted usually to agricultural pursuits; what little quartz mining had been done had been performed by the primitive operation of gadding out seams of the richer ore, which was ground under rolling-stones and the residue panned to obtain the gold contents. The population had had no experience in the use of modern mining equipment. Local wages were 10 cents per day; the company paid the miners 25 cents per day at first; later this rate was somewhat increased. The communication facilities of the country were of the most primitive kind—the roads were almost impassable, the bridges were removed in the rainy season and were replaced each year.

In the past 19 years the company has erected six mills with 245 stamps, three cyanide works, hydro-electric plant including a dam 80 ft. high. It has established four general stores and a transportation service employing five vessels. It has mined and reduced 4,300,000 tons of ore, which yielded $22,500,000, and it has paid in dividends to the shareholders $7,500,000. To accomplish this it has used only some $100,000 for development of the mines and the equipment of the property, everything other than that sum has been paid out of profits. The company has employed from 3500 to 5000 natives and rarely more than 60 foreigners.

Considering the low grade of the ore treated and the necessity of breaking ground in a locality so isolated from all mining facilities and traditions the results certainly have been remarkable. In your opinion what were the chief factors in accomplishing these?

First, the lack of capital; this compelled the most rigid economy in the early days of the enterprise.

Second, the almost exclusive employment of native labor that was patiently trained to effective work by the small force of foreigners.

Have you any trouble now with the Japanese Government?

My experience with the Japanese has indicated to me that those of the official class controlling the Japanese Government affairs are broad-minded, clear-headed, and whatever their final motives be, and I do not question their good faith, I think they have too much sense to adopt a policy that is not just. My experience has been that while they have been exacting, to our cost and inconvenience, I cannot say that their action has been unreasonable or unjust, from their point of view.

They certainly have benefited the Korean people in all material matters by their excellent government—whether these benefits have compensated the Koreans for the suppression of their national spirit I am not sure.

I think that while the Japanese will not interfere with the operation of enterprises already in existence, they do not favor any new incursion of foreign capital into Korea, unless with very considerable and inconvenient restrictions.

You have then had over 50 years of mining experience.

Yes, and I have learned many things.

Will you mention some of the things you have learned?

I have already referred to the result of my experience in working in foreign countries and to my conclusions as to the influence of wage-rates upon mining costs.

The knowledge of mining costs you think a fundamental part of mining engineering?

Decidedly so. The first aim of the ore-seeker is to make a profit. If he fails in this he ceases to mine and the world loses the benefit of his production of the metals.

Has the science of metalliferous mining advanced during the fifty years of your experience?

Certainly.

What influences do you consider have chiefly brought about the improvements?

In my opinion over 90% of the progress is due to the following three agencies.

1. The work of the chemist and metallurgist. They have improved reduction methods, explosives, and the value of alloys.
2. The engineers, who have introduced labor-saving contrivances.

3. The general education of the managers of mines and their use of more scientific methods.

In what direction do you look for further advances in mining efficiency?

Doubtless the chemist, metallurgist, and engineer will be of further very material benefit, but probably the greatest advance will come from a better understanding of the proper relations between the employer and employee; in metalliferous mining usually the largest expense is labor, and by obtaining the best results from labor most important benefits will follow.

What do you consider the best method that can be employed for increasing the efficiency of labor?

A sympathetic study by the employer of the point of view of the employee, and a system of profit-sharing that will tend to give the employee the point of view of the employer. The raising of wages cannot go on indefinitely without resulting in the closing-down of the poorer mines.

What is your opinion of mining as a business investment?

While mining has its venturesome side—made especially attractive by the almost limitless possibilities of profit—the general impression that all mining investments are peculiarly hazardous and speculative is, I think, wrong. In my experience some of the soundest business men I have known have been persistent investors in mines. In choosing their enterprises they have not been led away by the temptation offered by optimistic promoter's circulars, but were guided by sound consideration of the statement of men of character, ability, and experience.

Mining has its peculiar risks, but broadly speaking, no business enterprise is free from risk, although it may be of different character and come from different causes. The risk of mining, of course, is obvious to any man with mining experience; it is obvious to us mining engineers, just as the risk of farming and real estate speculation is obvious to farmers and real-estate agents. That man is wise who deals in the things the risk of which he understands.

A FORCE OF KOREAN MINERS AT THE TARACOL MINE OF THE ORIENTAL CONSOLIDATED MINING CO.

Therefore, Mr. Perkins, you will agree with me, I believe, that the mistake made by the public is not in considering metal mining a desirable form of using money, but the forgetting of the fact that it involves risk. Do you consider metal mining a legitimate form of investment?

Yes, I do, when the profit is sought from mining ore and not from kiting shares; in other words, by legitimate return on capital and not by the fictitious enhancement of the principal. 'Income' from mining investments is apt to be a misleading term if one forgets that the income

includes, in large measure, a return of capital, and many people who are accustomed to other kinds of investment overlook the necessary amortization of capital. Personally I charge the return from a mine to 'capital' until all the capital has been redeemed, and thenceforward I regard the return as profit. Moreover, I recognize that it is a profit that may cease at any time.

What is your opinion respecting the propriety of managers of mining companies—whose shares are on the market—dealing, excepting as investment, in the company's shares?

While there is nothing in itself dishonest in their doing this, I consider it a dangerous habit. When a man prays to be delivered from temptation he should not invite it.

You have known of many large fortunes accumulated through mining investments?

Yes.

Have these been made by share speculation or in a legitimate way?

I believe that almost without exception the large mining fortunes have been made by investment in mines that have yielded their owners a profit by the extraction of minerals from the ground, and that few, if any, of the large sums coming from purely stock speculations have resulted in permanent fortunes. Nor do I think mining promoters have been often successful in accumulating fortunes that have endured, excepting when they have dealt in mines of intrinsic value.

Do you favor publicity in the conduct of public companies?

I think that the shareholders in a public company are entitled to know everything as to its affairs that the management knows, and that hiding is not only indefensible but it is nearly always injurious to the best interests of the concern. Suppressing information deceives the unwary and aids the dishonestly disposed. Secrecy concerning the operations of a public company tends to create suspicion in the minds of the subordinates as to the good faith of those in control, it is likely to lower their moral standards and to discourage their enthusiastic co-operation. I am aware that the policy of secretiveness is often followed from good motives, but I believe it usually proves to be a mistaken policy.

To what, in your mining experience do you look back upon with the most satisfaction?

To the development of personalities and to the advancement of my subordinates from inferior positions to those of greater responsibility. I have been able to start a considerable number of young men on careers of great usefulness, and I have not felt that they were in debt to me for their successes, for the benefits arising from the association have been mutual.

What do you consider the chief factors you have employed in the development of these men?

The throwing upon them of responsibility and showing trust in them.

What qualities do you chiefly look for in selecting mining managers?

1. Strength of character.
2. An honest intellect which sees the facts as they are and not only as one may wish them to be.
3. A disposition to be just to the employee as well as to the employer.
4. A practical working experience.
5. A technical training.

While all of these qualities are rarely at first combined in any one individual they can be quickly developed in most individuals of fair character and intelligence.

Do you think mining is a good career for a young man?

Yes, for a good man who is likely to develop a love for the work. It seems to be that today there is less oversupply of mining engineers than of doctors and lawyers.

Have you any expectation of the expansion of mining as a world-wide industry?

There is an increasing demand for the metals and an increased supply of capital available for the exploitation of mines. Therefore, I expect an increase in mining activity the world over.

You were at Juneau last summer; how were you impressed by the new enterprises for the mining of low-grade ore?

I found the mining and reduction methods lately introduced at Juneau most interesting and instructive. If the companies operating there at the high rate of wages prevailing can demonstrate that hard ore can be extracted from underground workings and reduced profitably when the yield is only $1 per ton, all hard-rock mining men will recognize that a new mark for efficient mining work has been established and the world will benefit by having its available wealth increased.

THE ACID RESISTING properties of some iron-silicon alloys was tested by O. L. Kavalke, taking 18 low-carbon iron-silicon alloys, containing 1.2 to 19.8% silicon, which were immersed from periods of 51 hr. to 29 days in 10% solutions of sulphuric, hydrochloric, nitric, acetic, and citric acids, and the losses determined. With a few irregularities the resistance to acid-attack was a minimum at 1.2 to 3.3% silicon, and a maximum at 16 to 18%. The latter alloys are hard and brittle. Attempts are being made to find an additional element which will decrease these undesirable qualities while not impairing the resistance to acids. The conclusions from the experiments were that (1) silicon-iron alloys of about 3 to 5% silicon are attacked readily by sulphuric, hydrochloric, acetic, and citric acids, and such alloys are not excessively brittle; (2) silicon-iron alloys of about 16 to 18% are exceedingly resistant to the action of sulphuric, hydrochloric, nitric, acetic, and citric acids, and the alloys are so brittle that they must be ground; they cannot be machined; and (3) a solid solution of FeSi in iron near 20% silicon is resistant to mineral acids.

SCHEELITE in large masses is reported to have been found recently in the southern part of New Zealand.

OUTCROP OF THE WHALE VEIN. THE TELLURIDE CHIEF MINE.

Molybdenum in the Hualpai Mountains

By L. WEBSTER WICKES

The Hualpai mountains, pronounced and sometimes spelled Wallapai, are situated near the centre of Mohave county, Arizona, south and east of the main line of the Santa Fe railway, and rise from 2500 to 5000 ft. above the Big Sandy valley on the east and the Sacramento valley on the west. Hualpai peak attains an altitude of 8266 ft. above sea-level. The range extends north and south about 40 miles, with a maximum width of 15 miles.

The geology of the Hualpai range was described by W. T. Lee in Bulletin 352 of the U. S. Geological Survey and in Bulletin 397 by F. C. Schrader. Schrader says, "These mountains are composed of pre-Cambrian granitic rocks, and seem to be a fault-block tilted eastward." The slope is steep to the west, where there exists a wide belt of gneiss and several strong faults. Mining has been carried on intermittently here since 1871, when members of Lieut. Wheeler's exploring party found vein outcrops containing silver and gold. Silver was the object of search in the early days and resulted in the opening of a number of properties, mostly on the east slope. Later developments were on outcrops of copper and lead-zinc veins. During the last few years tungsten has excited interest. From some of the tungsten properties regular shipments of hand-sorted ore are being made. Bismuth and vanadium minerals are also found. Molybdenum has been known in these mountains for a long time. Traces of this metal are generally found wherever the surface has been eroded to the pre-Cambrian complex in Mohave county. It usually occurs as molybdenite, although occasionally wulfenite is found in the lead veins. It is most abundant just north of Wheeler wash, and near Deluge wash, both of which lead into the Big Sandy. Wheeler wash is near the north end of the range, and the properties are from 20 to 25 miles from Kingman. The Deluge area is 25 to 30 miles from Yucca, and was the first one in the district worked for molybdenum, where the Leviathan Mines Co. and the American Mineral & Chemical Co. are now operating. A description of the Leviathan is given by F. W. Horton in the Bureau of Mines Bulletin 111.

In the vicinity of the molybdenum deposits the country is a medium-grained granitic rock, which extends north and south for some distance, and must be very wide, but its east boundary is hidden by detrital material. It seems to be intrusive through coarse red granite and gneiss. Dark basic dikes are found to the south, west, and north, while several miles north-west rhyolite and latite are found. Near the deposits are small pegmatite stocks, which, however, seem to have no connection with the mineralization. The ore occurs in veins running nearly parallel with the main ridge and conformable to the principal jointure of the granite. It is a white quartz containing molybdenite and chalcopyrite, outcropping prominently. On the Whale vein, of the Leviathan company, the outcrop is strong for 1500 ft., with 'pinch and swell' from 18 in. to 30 ft. Underground it shows an average width of over 3 ft. There is a shaft 135 ft. deep, and about 700 ft. of driving and tunneling has been done. This vein is distinguished by crossing instead of conforming to the jointure of the granite. There is also more evidence of movement; the foot-wall being a clean slip, while the hanging wall is irregular. The metal-content is fairly uniform in veinlets, stringers, and drusy material. I. C. Stricker, the manager, states that the ore gives an average of slightly under 2% MoS_2, and a trifle over 2% copper. Bunches of high-grade are found repeatedly, and in one case a lens yielded 700 pounds of 67% ore. I estimate that over 16,000 tons of 2% ore is ready for stoping, and at least twice that amount of probable ore, while the possibilities are much greater. This relates only to the Whale vein, and there are others that give promise. A

50-ton mill has just been completed, and the first shipment of 30% MoS_2 concentrate is now being made. Concentration is entirely by flotation at present.

The Wheeler wash section presents a condition different from that at Deluge wash. The strong outcrops of quartz are entirely lacking, and no definite vein-system has been discovered. The country rock is similar, but lacks some of the accessory minerals. It has a finer grain and is sometimes porphyritic. It is interesting to note that though biotite is a constituent of the country rock, it seems to decrease in amount and is entirely lacking at places in close proximity to the ore deposits. This effect is sometimes noticeable for a distance of 10 feet.

In the granite at Wheeler wash are a number of north and south fractures showing a little movement. These show alteration and silicification, sericite and kaolin having also been developed. There are veinlets of secondary quartz, usually ¼ to ½ in. wide, and occasionally as much as 4 inches. The fractures are nearly vertical, and are intersected at right angles by a system of minor vertical faults, with the throw nearly horizontal. These movements have produced coarsely brecciated zones in which the molybdenite is found. Where the alteration has been the greatest the percentage of molybdenite increases. Molybdenite is also found as thin flakes on the fault planes.

On the ground of the Telluride Chief Co. is a shaft 200 ft. deep with 350 ft. of work at the bottom. Roy Cornell, resident engineer of the company, informs me that a zone 30 ft. wide which has been cross-cut, assays 1% molybdenite. The total area where the molybdenum has been found is about one by two miles in both the Wheeler and Deluge wash districts. These areas are nearly 12 miles apart. The intervening country is being actively prospected.

Milling the ore is a serious problem. With the exception of some on the Arizona Molybdenite Co.'s ground, the ore contains pyrite and chalcopyrite. Buyers of molybdenite formerly insisted on having a product containing less than 1% copper and over 60% molybdenite. At the present time this condition does not have to be met, but will again in the future. The high percentage of chalcopyrite makes it difficult to obtain clean molybdenite. The American Co. has had an experimental mill in operation for some time; the Leviathan has just completed its new mill, with a capacity of 50 tons; and the Arizona Molybdenite Co. has a mill under construction. Considerable testing has been done with laboratory flotation-machines and good results obtained. It has proved difficult to bring the copper content below 5%. A good copper product is made in the laboratory, and it should be only a matter of further experimenting before it can be done in practice. Good results have been obtained by using a light oil, making an evanescent bubble, in a machine that can be skimmed quickly. Upon the addition of a heavy oil in a machine with long spitzkasten, the copper product is obtained. An ammonium resinate has been successfully used to float the molybdenite and leave the chalcopyrite behind. The best method has been to make a concentrate in the first machine, floating all the sulphides, and then subjecting this concentrate to a light roast, after which the molybdenite can be readily floated leaving the copper and iron in the tailing.

The method of analysis which has been found most satisfactory, particularly when much copper is present, was developed by R. C. Jacobson of Mohave. It is as follows: Weigh 4 gm. in a casserole and add 10 cc. nitric acid; cover and heat to decomposition. After brown fumes have ceased, add 0.5 gm. potassium chlorate and heat until chlorine has ceased coming off. Add 3 cc. sulphuric acid, and evaporate to white fumes. Be sure that all the nitric acid has been expelled. Cool; dissolve in water and heat on the hot-plate until all has gone into solution; cool, and add an excess of ammonia (at least 5 or 6 cc. ammonia to 25 or 30 cc. water after the solution is neutralized). Heat to boiling for a few minutes, transfer to a 100 cc. volumetric flask; cool and dilute to the mark. Mix and pour through a dry filter into a beaker. Draw off 50 cc. with a pipette, and place in another 100-cc. flask. Add cautiously 10 cc. strong sulphuric acid and rinse it down with a wash bottle; then add 0.3 gm. powdered aluminum. Give the flask a rotary movement to stir thoroughly, and rinse down the aluminum. If the flask is too hot and acts too strongly on the aluminum, cool slightly in water. The heat should be just sufficient to insure ready action on the aluminum, but not to cause it to foam. The flask is then set aside for about 10 min., shaking it at intervals. Cool and dilute to the mark. Place a plug of absorbent cotton, firmly pressed down with the fingers, in a dry funnel and place underneath a dry beaker containing a piece of aluminum foil. Pour off the reduced molybdenum solution, containing the powder, through the cotton. The object of the foil in the beaker is to prevent the molybdenum from re-oxidizing. The solution should be run through rapidly for the same reason. It should have a clear green color. Draw off 50 cc. with a pipette, which should represent 1 gm. of the original ore, and titrate with N/10 permanganate solution. From the number of cubic centimetres used deduct 0.3 for the action of the impurities of the aluminum product (it is best to run a blank test against 0.3 gm. Al), and multiply the remainder by 0.00533 for MoS_2, or by 0.0048 for the molybdenum oxide, MoO. Continue the titration till the pink tint from the last two drops does not fade out for at least one-half minute. With ore containing 10 to 25% use only 2 gm. of the ore, and for those above 25% use only 1 gm. A small amount of aluminum running through the cotton will affect the result, and make the end point indistinct.

ESTIMATES from present incomplete exploration of the coal areas of the United States of Colombia give an available supply of over 27,000 million tons of bituminous coal. Peru has 1339 millions of tons of bituminous, and 700 millions of anthracite. Chile, according to the governmental estimates, has resources of bituminous coal amounting to 3048 millions of tons.

Secondary Enrichment of Zinc Deposits

By FRANK L. NASON

*This overworked term seems to be covered by 'aggregation' or even by 'segregation.' Leaving it at its face value so far as zinc deposits are concerned, evidence gathered from a wide range of observation points to subtraction rather than to addition, in many if not in all cases, in accounting for rich deposits of oxidized ores. The Bertha mines in Wythe county, Virginia, are excellent examples of the point in question. The surface of the worked deposit was originally covered by a thick mantle of clay. Mining disclosed pinnacles or chimneys of limestone as high as 100 ft. Some of these pinnacles were coated with oxidized ores and the 'valleys' were occasionally floored with massive deposits from 5 to 40 ft. thick. In addition, there were layers of soft and hard 'buckfat' carrying from 15 to 17% zinc. The chimneys, while showing some blende, were nowhere as a whole of economic value. In no place was there blende sufficient to account for the probable average of 15% zinc in the valleys between the pinnacles. The conclusion seems warranted that the rich mass of oxidized ore had been formed by aggregation from the blende-bearing limestone. Yet examination shows that the chimneys and floors are of dense compact dolomite with no evidence of even capillary channels, through which the solutions might have traveled. This would leave the only source of enrichment to the overlying blende-bearing dolomite. But on all sides of the old workings the surrounding dolomite is barren of zinc. There are no visible channels or sources from which or through which enriching solutions could come. The conclusion seems inevitable that the rich oxidized Bertha deposits were formed *in situ* by the subtraction of the soluble dolomite in which the zinc orebody was originally present in the form of sulphide. This conclusion was almost completely demonstrated at the Austinville mines about 8 miles south-west. These mines were originally worked for oxidized lead exclusively, later for both lead and zinc sulphides. The outcrops are about 235 ft. above the base-level of the drainage of New river. Mining here disclosed the same chimney-formation as at Bertha, and the oxidized ore was of the same character. The clay in places was 90 ft. thick. Instead, however, of the ores being confined to chimney-coatings and to floorings, at least 6 well-defined blankets of oxidized ores were followed, not continuously, for at least 6000 ft. on the strike and were down on the dip to the level of the river. At this level the original sulphide appeared to the exclusion of the oxidized ore. In other words, in repeated instances, oxidized ore was followed down to the original sulphide and this, in turn, has been followed down to the 435-ft. level, 200 ft. below the base level of drainage. The combined lead and zinc averages about 14%, large masses assaying as high as 30%. There seems to be no possible doubt that the rich oxidized ore, averaging upward of 40%, was formed by subtraction of the dolomite, not by the extraneous addition of zinc and lead.

Another striking example is to be found at the New Prospect mine in Union county, Tennessee. This mine may be represented by a prism about 900 by 50 by 90 ft. For 600 ft. the western end of the prism consisted wholly of oxidized ore. The bottom 20 ft. of the mine is shattered dolomite assaying about 20% combined zinc and lead. For 30 ft. above this the combined metals average about 10%. Here the rich oxidized ore was derived from the decomposition of the mass in place, the result being that the soluble dolomite was, in the main, leached out, leaving the oxidized lead and zinc. This is another example of subtraction, not addition. The same conclusion is reached at the Straight Creek and Mascot, in Tennessee; the Hanover, Kelly, and Cleveland in New Mexico; the San Xavier in Arizona; the Leadville and Gilman veins in Colorado; the Tiro General, La Bufa, Cruz del Aire, and other mines in Mexico and the United States. In Guatemala and San Salvador are mines showing the same characteristics. In each of the mines cited, rich oxidized ore has been followed down to correspondingly rich sulphide. The Bertha and Delton mines in Virginia, the Embreeville, New Market, and Mossy Creek mines in Tennessee, show no commercial zinc sulphide below the oxidized surface ore even with fairly extensive drilling. Some mines in Wisconsin and in the Joplin field (in its most comprehensive meaning) seem to be examples where the subtraction has been carried to the point of exhausting the zinc and lead as well. In these instances, where masses of stained clay give evidence of the work of meteoric waters, secondary enrichment ought to have followed. On the contrary, however, these waters have removed not only the limestone but most of the zinc as well.

There is a peculiar mine near Santa Eulalia, Chihuahua, Mexico. A shaft about 1100 ft. deep was sunk through a rotted rock of undetermined origin; then came about 200 ft. of oxidized ore, then about 200 ft. of zinc and lead and other sulphides, and finally, oxidized ores again. In the zinc mines of Alotepec, Guatemala, are great dike-like masses of garnet in which zinc and lead assay as high as 16%. The galena and blende often come to the surface. In places, however, the blende is decomposed and the cavities are largely filled with zinc oxide. The mine outcrops for about 2½ miles along the Rio de las Minas. The greater part of the ore-zone has a hornblende gangue instead of garnet. The hornblende is badly decomposed but carries zinc oxides from 3 to 11% zinc. When undecomposed hornblende is found, zinc in the form of sulphide is found in the same quantity. In the San Juan de Calera mine in San Salvador, zinc and lead are present to the extent of 39%, mainly as sulphides. The gangue is garnet and occasionally, as at the Alotepec mines, the cavities in the garnet are filled with zinc oxide. In the same district is the El Tejada mine. No blende was observed here but loose sheets of high-grade calamine were seen. These were observed in both jointing and bedding planes, flanked with

*Abstract: Characteristics of Zinc Deposits in North America, Bull. A. I. M. E., May 1917.

rotted granular masses of white limestone. The rotted planes were from a few inches to 5 ft. thick, succeeded by blocks of fresh limestone. The faces resembled masonry walls, the calamine representing the mortar. At Hanover, New Mexico, oxidized ores with rotted hornblende abut in places against solid garnet carrying upward of 5% zinc as blende, while oxidized ore also occurs in jointing and bedding planes.

Correction Chart for a 500-Ft. Tape

By WALTER SCOTT WEEKS

In response to a letter I have prepared a new chart for correcting a steel tape for sag, stretch, and temperature. This chart gives corrections for tape-lengths from 200 to 500 ft. A person who intends to use this chart should read the discussion of the theory upon which it is based. This may be found in the MINING AND SCIENTIFIC PRESS of October 28, 1916. In that article I gave a chart for correcting tapes from 0 to 200 feet.

The present chart can be used for correcting a steel tape of the specifications given in these articles.

The pull to be exerted on the tape shall be 6000 times the weight of one foot of tape. This pull will induce a unit-stress of about 20,000 lb. per square inch. The pull may be measured at either the upper or the lower end of an inclined tape.

Compute the temperature at which the tape is correct in length with no pull and entirely supported. This is the standard temperature. Use the tape with a pull that equals 6000 times its weight per foot. Subtract algebraically the standard temperature from the temperature at which the tape is used, to obtain the 'variation from standard temperature.' Place one point of a pair of dividers on the intersection of the temperature line and the length line and the other point on the intersection of the sag line and the length line, and transfer this distance to the scale at the left where the correction is read in feet. For example:

A 500-ft. tape weighing 0.005 lb. per foot is standardized at a 20-lb. pull and 60° F., and is found to measure 500.10 feet.

It is first necessary to compute the standard temperature.

The working pull is $6000 \times 0.005 = 30$ lb.

From the chart, the stretch with working-pull $= 0.351$.

Hence the stretch with 20 lb. is $\frac{20}{30} \times 0.351 = 0.234$.

The length of the tape with no pull would be $500.10 - 0.234 = 499.866$.

The tape with no pull is 0.134 ft. too short.

The temperature must now be raised enough above 60° to correct the length of the tape.

Raising the temperature 1° will increase the length of the tape 0.00325. To increase the length 0.134 ft. the temperature must be raised $\frac{0.134}{0.00325} = 41°$.

The standard temperature of the tape is then $60 + 41 = 101°$.

This is the temperature at which the tape is correct in length when entirely supported and no pull is exerted.

Let us suppose that the tape is used to measure the distance between two points; the tape reading is 440 ft., the temperature is 81°, and the angle of inclination of the tape is 70°.

The directions given above should be followed, thus

$$81° - 101° = -20°$$

Place one point of a pair of dividers on the intersection of the temperature line marked −20° and the length line marked 440, and the other point on the intersection of the sag line marked 70° and the length line marked 440. Transfer this distance to the scale at the left where the error is seen to be 0.24 feet.

If the temperature line is above the sag curve the correction must be added; if the sag curve is above the temperature line the correction must be subtracted. In the present case the true distance between the points is 440.24 feet.

The error in the correction given by the chart is in no case greater than 0.02 feet.

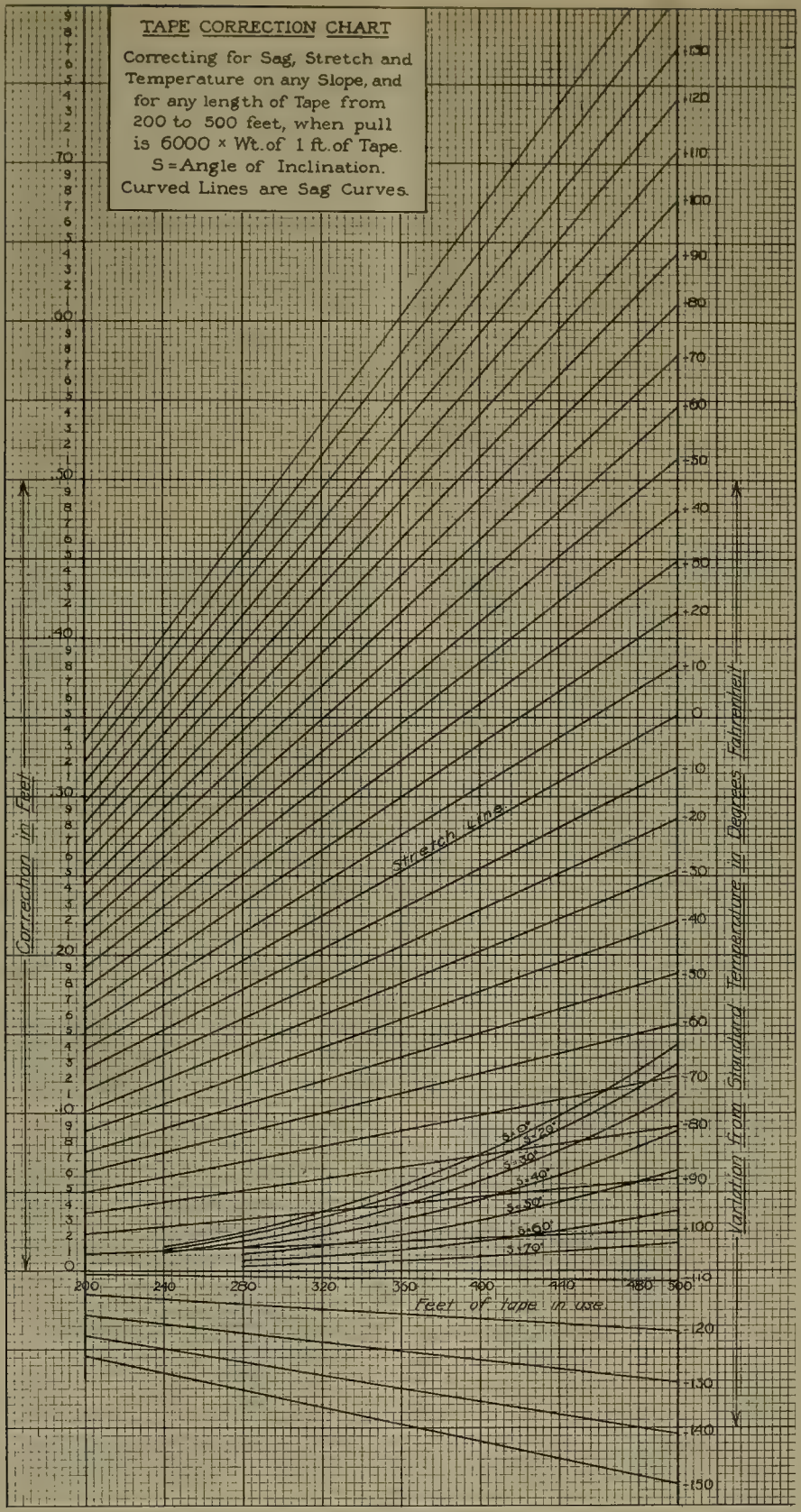
A stop should be placed on the spring-balance as described in the MINING AND SCIENTIFIC PRESS of November 4, 1916, page 668, in my article entitled 'Measuring With the Steel Tape in Mine Surveying.'

RUSTING OF CAST-IRON was made the subject of a series of tests by E. A. and C. T. Richardson, in comparison with steel and pure iron. The results of seven months exposure to oxidizing influences showed that the losses of metal, computed in grammes per square centimetre of surface, were for cast-iron, 0.966 gm., for pure iron, 0.771 gm., and for steel 1.546. The cast-iron corroded in a manner similar to the pure iron, while the steel was deeply pitted, and the rusting had been quite irregular. The analyses of the test-pieces were as follows:

	Sulphur	Phosphorus	Manganese	Total carbon	Silicon	Copper
Cast-iron ..	0.059	1.02	0.48	3.26	2.40	none
Steel	0.030	0.006	0.33	0.10	trace	trace
Pure iron .	0.021	0.004	0.015	0.015	0.005	0.025

The results of this test show that the resistance of an iron to corrosion does not necessarily depend upon its purity or homogeneity, as would be indicated by the electrolytic theory of corrosion. This theory, in its present accepted form, does not explain the great resistance offered by cast-iron to corrosion. While it may be true that the initial rusting is largely electrolytic in character, other factors, such as the adherence of the rust and the protection thereby given to the metal, come into operation and outweigh any electrolytic corrosion—a conclusion that has also been arrived at by other observers.—*Trans. Amer. Electrochem. Soc.*

RIO TINTO, the oldest copper mine in the world, once worked by the Romans, and before them by the Phoenicians, last year paid to its British owners the handsome sum of £2,145,830 or about $10,500,000. That represents an earning capacity of 95% on the capitalization of the company.


TAPE CORRECTION CHART
Correcting for Sag, Stretch and Temperature on any Slope, and for any length of Tape from 200 to 500 feet, when pull is 6000 × Wt. of 1 ft. of Tape.
S = Angle of Inclination.
Curved Lines are Sag Curves.
Correction in Feet
Variation from Standard Temperature in Degrees Fahrenheit
Stretch Line
S=0°
S=10°
S=20°
S=30°
S=40°
S=50°
S=60°
S=79°
200
240
280
320
360
400
440
480
500
Feet of Tape in use

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

FUEL EFFICIENCY in steam-making is the ratio between the heat absorbed by the boiler and the heat-value of the fuel burned.

INJECTION under the skin of a 3% solution of hydrogen-peroxide is said to be an effective antidote for poison by cyanide where the poison has been inhaled.

THE GRAIN-SIDE of a leather-belt should be run next to the pulley, as it adheres more closely than the shaved side, thus enabling the belt to transmit more power.

THIN ROCK SECTIONS, prepared for study under the polarization microscope, may be projected upon a screen in the same manner as photographic views in the stereopticon.

COAL CROPPINGS are often dull and earthy in appearance, sometimes of a brownish color. The coal improves in depth, though to what extent cannot be told from the surface exposure.

MERCURY BOILS at a temperature of 676° F., and at that temperature and higher it distills rapidly, though mercurial vapors will rise from the metal at a lower temperature than 676°.

ALLOYS OF LEAD, TIN, BISMUTH, AND CADMIUM are all easily fusible. One of these consisting of tin 4 parts, lead 8 parts, bismuth 15 parts, and cadmium 3 parts, melts at 55° C. or 131° F.

BOILER-FEED WATER should always be pre-heated, not only because it saves expense in making steam, but it causes much of the scale-forming minerals in the water to deposit in the heater instead of in the boiler.

COBALT has been produced at one locality in the United States in considerable quantity, namely, at Mine La Motte, in Missouri. The principal cobalt-producing region of the world at present is New Caledonia, where it occurs with nickel ores.

GOLD DREDGES are rated as to capacity according to the amount of material the buckets can dig within a stated period. Some of the larger dredges working under favorable conditions handle 3000 cu. yd. per 24 hr. Some claim to be doing more than this.

THE V FLUME in Madera county, California, is 53 miles long and cost $270,000. It is built of scantling and boards, has 36-in. sides and is 46 in. wide at the top. It was built to float lumber from the mills in the mountains to the valley.

WATER can be heated to a temperature of 212° F. only under atmospheric pressure, and this only at sea-level. When the water is confined so that pressure results and increases with rising temperature, the temperature can be raised to a high point.

CEMENT COPPER is the name given to metallic copper precipitated by scrap-iron from a solution of a copper salt. It seldom contains more than 60% copper. About 4 lb. of metallic iron is consumed in precipitating 1 lb. of copper in the tanks or precipitating-troughs.

BESSEMER ORE for making iron suitable for blowing to bessemer steel is one that will yield a grade of pig-iron containing not to exceed 0.10% phosphorus. While limits for the iron, silica, and sulphur-content are usually assigned, the controlling factor is the phosphorus.

QUARTZ is always crystalline but not always crystallized. Quartz is silica. The variety of silica called hyalite is not crystalline but amorphous—without crystalline form. Quartzite is metamorphosed sand-stone. Quartz occurs in the form of rounded or semi-rounded grains in granite, rhyolite, dacite, quartz-porphyry, and in a few other rocks. It also occurs abundantly in certain metamorphosed sedimentary rocks, such as jasperoid rocks, and quartzite.

THE United States Bureau of Mines, has caused to be issued pamphlets on 'elementary first aid for the injured miners.' These valuable bulletins are thus far printed in Italian, Polish, and Slovak, with the English equivalent on opposite pages, the object being that miners of foreign birth may have the advantage of the necessary instruction for rendering prompt aid to those injured in mines. It cannot fail to be of value in reducing suffering and in saving human life.

COBALT is chiefly employed in making paints and enamels. Several years ago it was reported that Thomas A. Edison had discovered a new use for cobalt, and would require a large amount of the metal, but nothing has been heard of this recently. Elwood Haynes has made a remarkable alloy of cobalt and chromium, called stellite, that is extensively used for high-speed tools in lathe-work. It also has been employed for acid-proof edge-tools.

TARNISHED silver may be cheaply and efficiently cleaned by the so-called 'electrolytic method' as follows: place in a clean agate-ware dish, in which the enamel is entirely unbroken, a solution of 1 teaspoonful of soda (soda-ash or baking-soda) and 1 teaspoonful of common salt to 1 quart of water. A sheet of aluminum or clean zinc is immersed in the solution in contact with the piece of silver to be cleaned. The two metals should be completely covered by the solution. Heat nearly to boiling. When the tarnish disappears from the silver, remove it; rinse with cold water, and wipe with a soft cloth. The amount of silver lost by this method is said to be 25 times less than that occasioned by cleaning with ordinary silver-polish or other abrasives.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

MOUNTAIN KING, CALIFORNIA

THE DISASTER AT THE MOUNTAIN KING MINE.—HEROIC BUT FRUITLESS EFFORTS OF THE SUPERINTENDENT AND WORKMEN TO RESCUE THE MEN.

The Mountain King mine is entered through a cross-cut adit on the 1000-ft. level. At a point 3000 ft. from the portal is what is known as No. 3 winze, which, including the sump, decends to the 1500-ft. level. There are drifts both east and west at the 1100 and 1200-ft. levels. These are extensive and are connected otherwise than through the winze by raises and stopes. The work of sinking the winze from the 1200-ft. level to about the 1500-ft. level is a recent development and a station has been cut at the 1400-ft. level and driving east and west on the vein has proceeded some distance.

On Saturday, April 28, at 2 o'clock a.m., after the night-shift working in the 1400 drifts had finished, the faces of the drifts were blasted as is usual. From 2 a.m., until 7 a.m., when the day-shift goes in, there is no work in the mine, but it has been the practice, while working in the winze, to open a valve on the compressed-air line, allowing the air to escape, thereby driving out the smoke and gas from blasting, so that the winze and drifts on the 1400-ft. level would be clear for the day-shift.

The mine derives its power from the company's hydro-electric plant, on the Merced river, through about a mile of flume. At a place close to the power-house there was a leak in the flume. This had not been serious, but at 3 a.m. on Saturday the leak in the flume began to give trouble. The plant was shut-down and the water turned out. This caused the stoppage of the air-compressor at the mine before the smoke and gas in the winze could be blown out.

At 6 a.m. the power-house operator notified B. C. Austin, superintendent of the mine, that the power was off and requested a crew to be sent to the power-house to make a thorough repair on the flume, necessitating a continuance of the shut-down for perhaps a half day. At 6:30 a.m., Mr. Austin notified D. DuFau, the mine-foreman, that there would be no work in the mine as air and power would be off for a good part of the day and directed him to send the men who would have gone down to work in the 1400 drifts at 7 a.m., to the flume. Mr. DuFau advised Mr. Austin that he wished to repair some track in the 1200-ft. level and asked to use a part of his gang there. Accordingly DuFau sent seven men down on the flume, accompanied by Austin. Seven others went into the mine and descended to the 1200-ft. level and went to work. When DuFau gave his orders, two of the men, being the most experienced miners, expressed a desire to go down the winze to the 1400-ft. level to see how the shots had broken. As there was to be no work done there, and aside from satisfying a curiosity, there was no reason why the trip down the ladder should be made, DuFau told the men that he did not believe it would be safe to go down as the gas had not been blow out. The miners scouted the idea, but DuFau strictly admonished them to return immediately from any point where they met gas.

The gang on the flume upon commencing work, took out a section 30 ft. long.

At 7:30 a.m. DuFau joined the gang working in the 1200-ft. level and remarked that the two men who had gone down below had not returned, and he immediately went to the shaft and descended the ladder. In a short time DuFau returned and shouted that the two men were in the 1400 and were gased. He called to a man to go up to the 1000-ft. level and if necessary out of the mine to notify Austin that two men were unconscious in the 1400-ft. level drift. The man, Benes, did as he had been directed and then DuFau called to another man, Galino, to accompany him for the rescue of the men. Before they could get to the shaft, three other miners who had heard the shouting preceded them and descended to the 1400-ft. level. DuFau and Galino may have succeeded in getting down to the 1400, but if so, they must have immediately returned as they were found lashed to the ladder, the former about 50 ft. and the latter about 80 ft. below the 1200-ft. level. In a few minutes Benes returned bringing two bottles of spirits of ammonia and immediately descended to the 1400-ft. level. In passing DuFau and Galino, he noted that they were unconscious and he gave them ammonia which revived them slightly. When he arrived at the 1400-ft. level he was faint; but constantly inhaled the ammonia. He found all five men, the two at the face of the drift, the others, where they had fallen in trying to get to the ladder, all unconscious, but alive. Although in great distress, Benes found a gunny-sack, cut it into five strips, soaked them with ammonia and tied a strip around the nose and head of each of the five men. By a superhuman effort he succeeded in dragging himself up the ladder, stopping long enough when he reached the men on the ladder to make them more secure and then climbed to the 1100-ft. level, evidently with the idea of getting to the 1000-ft. station, where he could give the alarm. He was found at the 1100-ft. level in very bad condition; but by strenuous efforts his life was saved. By this time Austin had arrived. He improvised a light car that could be lowered on a rope, lashed himself thereto and ordered the men to lower him with the idea that he could pick up one man at a time. He attempted to get DuFau, but fainted before he could cut him loose from the ladder. Three times he was lowered and three times was pulled up and revived. There were more than two score men who volunteered and almost fought to go down but Austin forbade it. A hand-pump was installed in the 1200-ft. station and all day air was pumped down the shaft and for hours a hose was played down the shaft. Meanwhile, as soon as Austin had received word of the disaster, he ordered a temporary section of flume to be constructed, but it was late in the afternoon before this was completed so it would carry sufficient water to operate the compressor and hoist, by which time the seven men had been dead for several hours.

The mine makes no gas naturally at any point, and the ventilation by natural means is perfect, except at the bottom of the winze, and this will soon have natural ventilation. Every safety-device and precaution that could be taken has been the rule at this mine, and it has been the policy of the management always to give warning of any danger to the workmen, both above and underground.

SUTTER CREEK, CALIFORNIA

RAPID RE-OPENING AND DEVELOPMENT OF THE OLD EUREKA MINE. A LARGE ORE RESERVE AVAILABLE.—THE TAILING TROUBLE AGAIN.

At the Old Eureka mine all the water has been removed from the shaft and men are engaged in cutting out the lower part of the shaft to conform to the double-compartment above the 1700-ft. station. As formerly worked, the double-compartment shaft extended to a point about 40 ft. below the 1700-ft.

station, and from there down there was but the one compartment. The present work of cleaning out and widening the shaft is between the 1700 and 1800-ft. levels. The company has built dams on the upper levels of the mine, and provided pumping-plants of double the capacity required to handle the mine-water under normal conditions, and a large concrete dam is now under construction on the 1700-ft. level, to take care of the water at that depth. The shaft and stations are lighted electrically, a complete telephone-system has been installed throughout the mine and the surface plant; also an electric-bell system, which flashes a light underground when the contact is made, this being in addition to the usual pull-bell system, which can be used in case of emergency. Another feature much appreciated by the miners, is the piping of fresh water to all parts of the mine for drinking and other purposes. The entire mine equipment, both surface and underground, is of the best. Cleaning out and repairing is in progress on several of the old levels and considerable work has been done, particularly on the 800 and 1200-ft. levels. On the last-named level, north of the shaft a vein 36 ft. wide is in sight. As the foot-wall timbers rest against the quartz the actual width is not known. The ore in the face is all good milling rock, assaying from $3 to $46 per ton. The vein is believed to extend continuously up to the 800-ft. level, and so far as known, no stoping has been done between the two levels, so a large reserve of ore is apparently ready for extraction, while other portions of the mine afford encouraging prospects. At the 1400-ft. station an old car was found filled with ore, just as it was left when the mine closed down, and tools of various kinds have been picked up in a remarkable state of preservation. The old timbers, too, are generally in excellent condition, owing to their forty years submersion. The excellent ventilating system now in use has practically dispelled the peculiar odors usually observed in a mine so recently reopened and the present owners are receiving great credit for the large amount of work accomplished in a little over a year's time. A large amount of money has been expended in opening up and re-equipping this old mine, but within the next year, the owners will doubtless see actual mining operations under way, with every prospect of reaping big dividends. The Old Eureka is credited with a production of approximately $20,000,000, and it is known that the methods in vogue during the former operation of the mine made it impossible to profitably work ore of a quality that would now yield handsome returns. In fact, only about 60% of the values could then be saved. The concentrate was then a total loss and amalgamation methods were extremely crude, so that modern methods applied to the ore now blocked out, and the probability of finding other parallel veins as the work proceeds, should insure the speedy success of this enterprise. T. Walter Beam is the general manager, and William Martin is underground foreman of the mine.

As a result of protests made by farmers whose valley lands are alleged to be damaged by the overflow of tailing, the mills of the Original Amador Consolidated Mines Co. and of the Keystone mines have been hung up and it is not yet known how matters will be adjusted.

The local miners' union, in which are represented the miners of Amador, Calaveras, and Tuolumne counties, has withdrawn from the Western Federation of Miners and will hereafter be known as the Mine Workers' Union of the Mother Lode. James Giambruno is the secretary.

At the Kennedy mine a new level is being opened at a depth of 3900 ft. The East shaft has reached a vertical depth of 4012 ft. The 3900-ft. station has been cut and a cross-cut started this week to reach the vein on that level. Three new boilers have been added to the power-plant, to replace smaller ones, and other improvements are under way. The Kennedy mine, which is one of the largest producers in California, employs 390 men and the pay-roll amounts to about $36,000 per month. Webb Smith is the superintendent.

Capt. T. Hoatson, of Michigan, and others interested in the Wildman-Mahoney property at Sutter Creek, are inspecting their property, and as one result of their visit, men are blasting out and tearing down the old head-frame over the Wildman shaft, which has appeared to be in danger of toppling over for several years past. In fact, the road past the hoist was closed several years ago, to prevent injury in case the building collapsed. Rumors of the early resumption of work there are not confirmed.

PLATTEVILLE, WISCONSIN

UNCERTAINTIES OF THE MARKET FOR LEAD AND ZINC.—MILITARY GUARDS PLACED.—HEAVY PRODUCTION.—NEW OUTFITS.

Unsettled conditions, especially affecting the spelter market, resulted in a season of lowering values on zinc-ore offerings all through the month of April. This influence was felt severely in the Wisconsin zinc field and production, under the most favorable conditions for normal recovery, fell far below that usually recorded at this time of the year. Regardless of the handicap, no abatement in exploration, mine development work, or plant-construction was shown. In every district of the field numerous drill-squads were at work testing new areas; mine development was hurried along, more particularly in the southern mining camps of the field, and new power and milling-plants were ushered into active service. Leading mine managers who were interviewed during the month confessed that still greater headway would have been made had labor conditions been more satisfactory. Wages are the highest ever known in the field. Mine foremen receive $4 per day; miners breasting, $3.50; trammers, most of whom labor under contract, $4 to $6 per day; hoist-men, $3.50; machine-men, $3.50; mill-men and helpers, $3.50 to $4; and electricians, $4, and yet, to one thoroughly conversant with the field, there is evident the need of at least 1000 to 1500 men. This abnormal demand for help is being met to some extent by the introduction of negro miners, and scores of white miners recruited from the State of Kentucky, who arrive in bunches of 20 to 30 at a time.

All of the leading operating companies feel intuitively that war-time demand for metal will compel a quick recovery of both price and demand for zinc. Some who are better able financially than others to carry heavy investments in ore piled up in anticipation of higher prices, are content to await developments and are not shipping the current output, merely sending enough ore to market to meet the operating expenses. Where contract arrangements cover the output, deliveries are maintained at the usual rate.

Military precautions have been taken at several points in the field, where the foreign element predominates among the workers. The big works of the New Jersey Zinc Co., at Mineral Point, are under the constant guard of the State militia and the company's mines, at all points in the field, are likewise under the protection of the militia. Powder-magazines also are carefully guarded. Trusted employees have been appointed to look after stocks of dynamite and miners leaving the field are subjected to a rigid inspection of all their belongings. In not a few instances have miners' suit-cases been found to contain explosives in quantity. The Mineral Point Zinc Co. presented ten of its mines with flags 9 by 18 ft., which are flung to the breeze each morning from tall poles, and at dusk the colors are lowered and 250-kw. incandescent lamps are hoisted under large reflectors to illumine the grounds at night. Search-lights play about the mills and buildings. The Vinegar Hill Zinc Co. performed a real patriotic duty when it presented its men, in the Galena district, with $1000 worth of seed-potatoes for planting and turned over big tracts of ground for cultivation for their benefit.

Zinc-ore prices opened up in the first week of April at $85 per ton base, 60% assays and premium grades, with the range down to $80 for medium and second-grade ore. While this

was considerably below the high prices for March, operators felt no apprehension of sharp declines and outputting proceeded at fairly normal capacity. The week ended April 14 brought a drop of $5 per ton in the base-price with even sharper reductions on inferior grades, the range receding to $72.50. By April 21 the top quotations had again been trimmed, the base-high being placed at $72.50, with the range down to $70. Further reductions came with the closing days of marketing for April, the base standing at $70 per ton at the close of the month, with the lower quotations at $65. W. M. Smith, general manager of the Vinegar Hill mines and refining-plants, when questioned as to whether or not war-time demand for zinc would bring a return of higher prices, replied that in his opinion it would not, but that he believed it would prevent further declines. This view appears to be taken by other operators in the field. Low-grade zinc-ore producers suffered as a result of the lower offerings, many being unable to market ores containing under 40% zinc. Very little low-grade zinc ore came through during the month from the small independent-operating firms that were compelled to offer their ores for sale on open-market quotations. Such ore as did come from these sources was shipped under contract, or under 'gentlemen's agreements,' but few districts were favored in this manner. There was a fair reserve of both low and high-grade zinc ore in the field at the close of the month.

Lead-ore production in the field showed little appreciable gain through April, but preparations were made at several new mines for an output that will begin to assert itself later. Prices held at the beginning of the month at $110 per ton for 80% metal, and a good demand prevailed. In fact, some competition developed, the Mineral Point Zinc Co. placing a buyer in the field. Retrogression in the price of ore was noted about the middle of the month and the offerings fell to a point at one time under $100 per ton. In view of the sold-up condition of the pig-lead market, and a constant and healthful tone in metal quotations, it was difficult to understand the reversal of form in lead-ore offerings. Producers who had held, notwithstanding high markets, for even better figures, had occasion to regret not unloading; as considerable ore was carried over. Prices, however, began to pick up again toward the close of the month and the 30-day period ended with lead ore back to $110 per ton, with offerings on fancy lead concentrate at $112. Shipments for the month were light and sales were variously distributed. The return of spring weather induced many small operating companies to invade shallow diggings where lead ore is found in the upper horizons and the Annex Mining Co., a new enterprise, provided a surface-outfit for an exclusive lead-ore producer on the Peaceful Valley Mining Co.'s lease in the New Diggings district. Lead production fell off with the lower turn-in of zinc concentrate, since most of the lead ore recovered in the field is obtained as a by-product of the wet concentration of zinc ore.

Shipments of iron pyrite showed improvement, more ore reaching the track from refining-plants. A genuine scarcity of cars during the first half of the month found refiners reluctant to use valuable cars for the loading of low-priced pyrites, and preference was shown for the high-grade zinc ore that was ready for delivery. The introduction of gondola cars for ore transportation, for the first time in the history of the field, relieved the situation greatly, all grades now going to market in open cars, the finished separator-product as well as the low-grade ore. The advantage of the new cars was shown by an entire absence of any 'claims' during the last week of the month, on account of a scarcity in cars for prompt loading. Shipments made from each source of production show that there is scarcely any competition among buyers for this class of mine output. The buying has been limited and the destination has been different with each shipment.

Producers of zinc carbonate fared as badly as those offering the higher-priced sphalerite, the lower offerings reaching all alike. The demand was off, buying being confined entirely to the Mineral Point Zinc Co., which at present is the heaviest producer in the northern districts. Mine improvement was shown by one of the independent producers, but work was planned looking toward underground development for heavier production at a later date. The price receded from $70 to $60 per ton down to $40 to $50. Many small operators, confined to underground labors during the winter months, were busy making preparations for the summer's clean-up. Open-air plants were rigged up and good weather will see increased output this season.

Deliveries by districts for April were made as shown:

Districts	Zinc, lb.	Lead, lb.	Pyrites, lb.
Benton	23,064,000	770,000	.....
Mifflin	5,876,000	60,000	.....
Galena	3,640,000	152,000	.....
Cuba City	3,342,000	.....	2,994,000
Linden	3,056,000	60,000	.....
Hazel Green	2,206,000	.....	.....
Shullsburg	2,172,000	150,000	.....
Platteville	1,140,000	.....	.....
Potosi	497,000	.....	.....
Highland	480,000	60,000	.....
Montfort	166,000	.....	.....
Mineral Point	66,000	.....	2,766,000
Totals	45,705,000	1,252,000	5,760,000

Shipments of wet concentrate for the month from the mines to refining-plants in the field aggregated 387 cars—15,167 tons; from refining-plants to smelters, 133 cars—5115 tons; mine-run ore to Grasselli Chemical Co., 67 cars—2575 tons; in addition the Mineral Point Zinc Co. shipped to the smelter at DePue, 2691 tons of calcined blende, bringing the total net deliveries for the month out of the field to 10,381 tons. This is regarded as being 3000 tons under the normal capacity; but it was difficult to establish a reserve in the field at the close of the month compatible with this figure.

The gross recovery of mine-run output for the month totaled 16,204 tons, which was considerably under the figure obtaining ordinarily, the shortage being estimated at 5000 tons. The introduction of new mines and mills makes it obvious that production had been curtailed.

A hasty survey of the field, taking into account the more noteworthy events occurring within it during the month, proves that it was a busy time. The Mineral Point Zinc Co. resumed operations at the Red Jacket mine, in the Centreville district. At the Highland-Kennedy mine a new well-bore at a depth of 500 ft. was tested for water for milling and was found deficient. A new surface-rig has been waiting upon the outcome of this development for more than a year and 60 miners are meantime denied employment. The O. P. David mine, at Montfort, has suffered serious mishaps. A walk-out of the men, who demanded better pay and shorter hours, was followed by the discharge of the entire crew, who were later replaced by a new outfit. A friendly tussle among miners in the change-house at one of the mines at midnight resulted in the explosion of a box of detonating caps, causing the death of one miner and the serious injury of seven others. Linden operators appeared before the State Railway Commission with a demand for more adequate power from the Mineral Point Public Service Corporation, declaring that there had been interrupted working-schedules because the capacity of the power-line did not meet the demand made upon it. Dodgeville district reported a new project with mill-building, to be known as the North Survey Mining Co. The Utt-Thorne Mining Co. secured the Pierson and McIlhon leases, in the Mineral Point district, and resumed operation in the Harris mine, restoring the mill-equipment. All three leaseholds will be operated through one central plant. Mifflin showed new mine development on the Dale Rundell farm, the output of which will be

combined with the Yewdall and Senator mines. The Utt-Thorne company discovered heavy zinc deposits in the mine-floor and have opened up for increased output. New strikes were made in the Platteville district for the Block-House Mining Co., which at the end of the month was holding $100,000 worth of choice dressed ore, demanding better prices. New mill-building was well along in the Cuba district for both the Standard Metals Co. and the G. O. P. Mining Co. The east wing of the Linden zinc refinery was destroyed by fire. New machinery will be installed at the National Separators to collect dust and gas-fume. Benton district made its usual fine showing and introduced a new shipper to be known as the Middie. The Strawbridge Mining Co. began the construction of a new power and milling-plant; the Vinegar Hill company has a new shipper with complete new surface-rig, to be known as the Meloy mine. The Northwestern railway began the construction of a branch line from Strawbridge to New Diggings, causing a building boom in the village, among mining companies and adjacent zinc-mining districts. Hazel Green district showed new development on the McMillan property that resulted satisfactorily after a new plant had lain idle for a year because of the failure in determining the main-range of ore when the mine was first opened up. The Rio Mining Co. has also developed a new lease showing big deposits.

The Wisconsin Zinc Co. dismantled its equipment at the Birkbeck mine in the Galena district and removed it to the Copeland mine, at Shullsburg, where it is being re-built. The Vinegar Hill Co. has supplied a new surface-rig to the Jefferson mine and the old works were squared up and put in working order. Water-pockets that were broken into at the Graham mine drowned out the miners, and required heavy pumping for two weeks at the rate of 3000 gal. per min., when operations were again resumed. The Wisconsin Zinc Co. finally has abandoned the Galena-Joplin separators, claiming that the plant was run down and could not stand up under the demands made upon it. It is owned by the Picher Lead Co. The Potosi district showed two companies in fair producing shape, the Wilson and Tiffany, both of which prepared for increased output. Drill-squads working for the Tiffany Mining Co. made rich strikes of both lead and zinc ore on adjoining leaseholds.

COBALT, ONTARIO

ORE RESERVES OF THE PETERSON LAKE DEPLETED, AND DIAMOND-DRILLING RECOMMENDED.—HIGH-GRADE ORE IN THE RAND CONSOLIDATED.—LA ROSE PRODUCTION FALLING OFF.—NIPISSING STILL HAS LARGE ORE RESERVES.—THE CROESUS MINE RICH IN GOLD.

The first quarterly statement, sent out to Peterson Lake shareholders since the new management assumed control, announces that the usual quarterly dividend of 1½% will be passed. The company has paid to shareholders to date $462,191. The reason for passing the dividend is found in the report of the consulting engineer, Frank C. Loring. This report states that the company has very little ore left to stope, but recommends further development and exploration by diamond-drilling, and the extension of the work on the present known veins, particularly in No. 2 shaft. S. G. Forst has been appointed managing director and W. A. Lamport, secretary-treasurer of the Peterson Lake Mining Company.

The Rand Consolidated Co. during the last week has moved a small steam mining-plant to its copper prospect in Strathy township, in Temagami forest reserve.——The annual meeting of the Beaver Consolidated Mines was held at Toronto, on April 24. In the annual report of the company, president Culver says of the new vein discovered at the lower contact of the diabase-sill on the 1600-ft. level of the mine: "This vein is six to eight inches wide, rich in silver, and on both sides of the vein for about four feet the wall-rock is heavily impregnated with leaf-silver. The discovery has caused a great deal of interest in the Cobalt camp, and while we are not yet in a position to say to the shareholders that it will actually make a new mine out of the Beaver, it is most encouraging."

The report shows the earnings of the mine for the year to be $499,690 from an output of 746,310 oz. of silver. Operating charges were $245,004, leaving a profit of $236,582, as against $128,929 in the previous year.

The annual report of the LaRose Consolidated Mines indicates a marked falling off in the production of silver at that property. During the year production amounted to 740,065 oz. of silver with a net value of $449,734, the treatment of which resulted in a net profit of $164,774. Since the commencement of mining for silver from the LaRose, thirteen years ago, the company has paid a total of over $7,000,000 in dividends. The mine reached its maximum of production in 1911, during which year approximately 4,000,000 oz. of silver was recovered. The company carried into 1917 a surplus of $727,169. Operating costs during 1916 were 46.39c. per ounce, as against a selling price of 64.89 cents.

Nipissing, as shown in the annual report recently issued, continues to lead all of the other silver mines of the Dominion. After having paid $1,500,000 in dividends during 1916, a surplus of $1,980,126 was carried forward into the current year. Ore reserves are estimated at 9,153,000 oz. as compared with 8,921,718 oz. the preceding year. Net profits were $2,028,866 as compared with $1,187,970 the year previous. The reason for this remarkable increase was the higher price received for the product.

The Croesus mine, at Matheson, Ontario, from which $120,000 in gold was taken in the sinking of the first 100 ft., and which is recognized as one of the spectacular gold mines in the world, has this week made another important strike in a cross-cut on the 300-ft. level. The newly discovered parallel vein, as so far determined, appears to be of great importance. The formation is basalt and for a width of several feet from the fissure is said to carry a high average gold content.

Never before in its history has mining operations in the Cobalt district been conducted with greater vigor than at present, and were it not for a lack of skilled labor, the 1917 production would probably constitute a record in value. In point of ounces, production is steadily falling off, having reached the zenith in 1911, during which year upward of 30,000,000 oz. of silver was produced. At present, despite the labor difficulties, production is being maintained at the rate of about 20,000,000 oz. annually. During 1916, Nipissing alone produced over 4,000,000 oz., valued at over $3,000,000, and of which over $2,000,000 was net profit. Flotation is now playing an important part in the treatment of low-grade ores at the various Cobalt mines. At the McKinley-Darragh, a force began this week excavating for foundations for a new oil-flotation mill. The plant will have a capacity of about 250 tons daily, and it will be equipped with a Marathon mill, in which the tailing from the stamp-mill, which has been deposited in the lake, will be dredged, re-ground, and sent to the flotation-cells. A drag-line excavator will be employed in recovering the sand from the lake-bed. The installation, it is anticipated, will be completed about the middle of August. Among other plants using the flotation-process are the Buffalo, with a plant good for 600 tons daily; Nipissing, an experimental plant of 300 tons; Northern Customs, 200 tons; Dominion Reduction, 100; Coniagas, 100 tons; and a number of smaller experimental plants.

At the 1600-ft. level of the Beaver and Temiskaming (at the lower contact) the results are encouraging. Although the work done is insufficient to determine whether or not a new mine has been tapped at that depth, one thing seems certain, and that is that the expense of driving through about 1000 ft. of barren rock (the unproductive diabase sill) will not have been in vain, the management being reasonably assured of returns sufficient to cover the cost of the operation, with every indication of a much greater reward.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

At the next meeting of the Alaska Mining & Engineering Society the subject of discussion will be the milling-process and underground operation of the Alaska Gastineau Mining Company.

ARIZONA

Mohave County

(Special Correspondence.)—Nearly 50 properties, exclusive of small prospectors' operations, are now working in the Chloride district, and several others are to begin work before the middle of May.

The Steffy custom-mill should be running in less than six weeks. An initial capacity of 250 tons has been arranged for, and contracts for more than double its capacity have been offered. Small property owners will be encouraged, and, wherever possible, will be given the preference, to encourage mine development in the district.

Jesse Knight's Bullion Hill is ready to start sinking when the power-line is completed. All the machinery is in place. Poles for the power-line have been distributed and work will start inside of 10 days.

The Payroll mine is again in operation. This time it is under a 10-years' lease to L. F. Martin, of Calexico. The south drift on the 400-ft. level will be extended 250 ft. farther. Good milling-ore has been opened up in this drift.

J. E. Carter has taken the Tuckahoe mine under lease and option and is having a hoist installed. The head-frame is up and all is in readiness to start sinking a new shaft. The property is an old producer. Mr. Carter has also taken over, under the same conditions, the West Star, which end-lines the Tuckahoe on the south, and is having a hoist put on the old 60-ft. shaft, which will be sunk to 200 ft. The vein shows up well where exposed.

W. P. McKay and J. J. Robertson are operating the Puzzle group and have ordered a hoist and compressor. Until its arrival the shaft is being sunk with a windlass.

The Merrimac, an old producer, is being re-opened by J. C. Rankin. A 9-hp. hoist has been installed. A new shaft is being sunk some distance east of the old one.

The company operating the Schenectady has contracted for 200 ft. of sinking. The contractors began at the 175-ft. level and have sunk 50 ft., following the vein. Two feet of good mill-ore has come in at the bottom. Bulkley Wells, of Colorado, is one of the principal owners.

Sinking has been resumed in the Rattlesnake shaft, which is down 80 ft. on the incline. A carload of ore, taken out near the shaft, is in the bins.

The Schuylkill shaft is nearing 800 ft. depth. No cross-cutting has been done since the shaft passed the 500-ft. level, above which a large tonnage of mill-ore has been developed. The company states that if the vein is found as expected on the 800-ft. level, mill construction will be commenced.

The Emerald Isle is bringing in a power-line to its plant and will, in a short time, be producing electrolytic copper. At the present time the leaching-plant has a capacity of 70 tons of ore daily.

The Gold Back has opened up 7 ft. of ore on the 150-ft. level that assays $24.22 per ton. Arrangements are being made with the new Steffy custom-mill for treatment of a part of its product.

The Tennessee is shipping about 200 tons daily, much of it from the 1600-ft. level, where shipping ore has been opened up carrying an ounce of gold, 15% zinc, and 8% lead.

The Copper Age mill is nearly ready to start, all the machinery having been installed. Belts are being adjusted and the machinery is being put through the usual trying-out process.

The Copper Age mine has opened up the vein for 90 ft. in each direction from the bottom of the 137-ft. winze that was sunk in the upper adit. Good ore of a milling grade is being developed. The main working adit is in 400 ft. and is opening up an ore-shoot, the extent of which remains to be proved.

Chloride, May 7.

Six cars of ore shipped recently from the Elkhart mine, at Chloride, to the smelters has returned a net profit of $5000. The shipment included both high-grade ore and ore of a class that is usually concentrated at the mine before shipment, but, as yet, the Elkhart is not equipped with a concentrating-mill.

CALIFORNIA

The supervisor of the State for oil and gas reports for the week ended May 5 as follows: New wells commenced, 16, making a total of 388 since January 1; 32 water shut-off; 14 re-drilling or deepening jobs, and 14 abandonments.

Nevada County

(Special Correspondence.)—Unwatering of the Allison Ranch mine has progressed to a depth of 260 ft. and two electric-pumps are clearing the shaft at the rate of 1800 gal. per minute. Repairs have commenced and within 30 days the management expects to start mining in the upper levels. The mill is rapidly nearing completion and will be ready for service when stoping starts.

Ten more stamps have been placed in operation at the Golden Center, making 30 in all. Construction of the cyanide-plant is progressing rapidly, with most of the machinery in position. Considerable work is going on from the 1000-ft. level and within a short time it is planned to start vigorous development of the Peabody mine, at Grass Valley, from the vertical Golden Center shaft. The Peabody adjoins the Gold Hill mine, which is owned by the North Star Company.

It is rumored here that early work on the old Conlan mine is under consideration. The property has been idle many years, but at one time yielded much rich quartz.

New capital has been interested in the Black Bear mine, four miles below Grass Valley, and it is announced that development will be urged with redoubled vigor. The property contains some ore of milling grade, and several small deposits of rich quartz have been found. A small mill and other equipment are on the ground.

Prospecting of the tailing deposited by pioneer hydraulic operations is proceeding at Cherokee, both with drills and prospect-shafts. Besides tailing vast bodies of gravel still in place are receiving attention. Some of the ground is said to be suitable for dredging. It is understood at Cherokee that the Guggenheims are financing the work.

Grass Valley, May 9.

Tuolumne County

(Special Correspondence.)—After several months of preparatory work everything is in readiness for beginning the development of the Confidence mine to a much greater depth. It is stated that sinking will be continued until the incline shaft, now down 800 ft., has reached a depth of 1600 ft. Driving

will proceed at the same time. To carry out the plans it will be necessary to increase the working force, which now numbers 15 men.

Equipment for operating the Monarch gravel mine in a practical and economical manner is being installed. The milling-plant will be ready for operation by May 15. Though the adit has not yet reached the principal objective point, gravel that can be mined and milled at a profit has been uncovered. Theodore DeMauris is superintendent.

A shoot of ore assaying from $10 to $40 was uncovered in the Duffield mine, near Arastraville, last week. The vein is from a few inches to 18 inches wide. The property was recently bonded to F. Cauldfield. The Duffield mine is east of the Dreisam and on the opposite side of the hill. All of the veins in this hill are repeatedly faulted.

Development work is being vigorously urged in the Shawmut, at Jacksonville, by the Tonopah-Belmont Company. Progress in sinking has averaged, it is said, 25 ft. per week.

Sinking is to be resumed at the Dutch mine at Quartz. The work of straightening and repairing the shaft was begun last week. In the short time since sinking was begun the three-compartment shaft at the Yosemite mine, adjoining the Rawhide, has reached a depth of 150 ft.——Operations have been suspended at the Columbus mine, near Cherokee, a mile and a half north of Tuolumne.

W. S. Fagan, J. A. McAllister, and L. L. Cofer have taken an option on the F. J. Munn ranch, on Moccasin creek, and will shortly begin work on a large vein that traverses the property. It is said to contain copper.

Sonora, May 9.

COLORADO

Boulder County

(Special Correspondence.)—The Denver-Boulder Tungsten Development Co., composed of mining men of Denver, which has been operating on Lee hill, has planned extensive development on the big dike in which the iron tungstate occurs. The property consists of ten locations, and, like the tungsten district farther west, the veins carry gold—in many places in sufficient quantity to make them profitable for the gold alone—and the ores of both gold and tungsten are frequently found in close association. The officers of the company are, Dwight S. Young, president and superintendent; Frank E. Wise, secretary; and G. P. Howard, vice-president and treasurer. The property will be under the management of S. V. Coffman, of Boulder. Development is being urged on the Swarthmore adit west of the General Lee group. This property is owned by Ohio capitalists.——Mrs. S. A. Martin, who owns the General Lee group, is negotiating with Denver people for the sale of the property.——The Revenge owners contemplate the erection of a mill at their property on Last Lake.——John A. Wilson has a large vein of medium-grade ore in the Lonesome group. He is interesting capital for the erection of a mill.——Wilson Davis will commence operations on the Last Lake Company's mine about the middle of May.——A large vein of silver-lead ore will be opened up on the Otto Victor property on Tennessee mountain, when the cross-cut adit now being driven reaches the objective point. Mill-runs of ore from the vein have returned good value in lead and silver.——J. D. Kohlman, it is reported, will place a mill on the Big Group this season.——The Highland Mary Mining Co. will soon commence work in its adit near Hesse. The proper type of machinery to be erected is being considered by the owners, Bauer and Black.——It is reported that Mr. Woods, of New York, soon will resume work on his holdings in this district.——P. M. Spratt's property is increasing in value as work progresses.——The flotation process is attracting a great deal of the attention of the mine owners in this district, and it is believed that it will solve some of the difficult metallurgical problems of Boulder county.

Eldora, May 8.

Jefferson County

R. B. Moore, in charge of the Golden station of the Bureau of Mines, states that the laboratory there is practically completed. The whole laboratory is planned to handle any rare-metal ore involving any of the following treatments: fusing, roasting, reducing, leaching with any acid dilute or concentrate, leaching with any alkali or salt solution. Any amount of ore from 50 to 500 lb. can be handled. In addition, there are two small leaching-outfits; one for acids and one for alkalis, whereby 5 to 10 lb. of ore can be tested.

IDAHO

Bonner County

A new company has been organized to operate the Keystone mines on Lake Pend Oreille, known as the Armstead Mines, Inc. H. H. Armstead is president, A. H. Burroughs and Karl Jungbluth, vice-presidents, H. D. Kingsbury, treasurer, and H. L. Brown secretary. It is said there are available 70,000 tons of $25 ore, the value being chiefly in silver. The mine was formerly a shipper. A long adit has been driven from near the lake-level, and this is to be driven to the vein. A large amount of equipment, including pipes, rails, engines, cars, Leyner-Ingersoll compressors and drill-sharpeners, has been delivered at the mine. The adit is in 1400 ft. and will be driven 2200 ft. farther where it is calculated the vein will be reached at a depth of 1600 feet.

MICHIGAN

Houghton County

(Special Correspondence.)—If the present rate of earnings is any criterion there is every reason for the belief that the Trimountain mine of the Copper Range Consolidated will approximate a million and a half in net earnings for 1917, basing the prediction on a 27-c. copper-market average for the year. And the average is better than 31c. for the first six months of the year. The most pleasing thing about the Trimountain property is the success which has attended this property in the past three years in underground openings. From the time when Trimountain became a part of the Copper Range it has been a question as to whether it could make good or not; and the profits have been exceedingly small. In 1909 there was an actual deficit of $47,841, notwithstanding the fact that the rock tonnage was just about the same as it was in 1916 when the profits were $1,236,048. Of course the price received in 1909 was 13c. and the price received last year was above 25c., but the real difference shows in the improved grade of rock. The mine yielded 16 lb. per ton in 1909 and 25 lb. per ton last year. For a period of four years from 1908 to 1912 the earnings were averaging under $50,000 a year and then the turn came and Trimountain changed from a questionable commercial property to an assured mining success. The management is entitled to great credit for this change, because the introduction of better underground systems resulted in a closer selection of rock, a more careful avoidance of poor stretches, and an intelligent use of every advanced mining idea.

Houghton, May 1.

MONTANA

Lewis and Clark County

(Special Correspondence.)—The Rock Rose shaft of the Cruse Consolidated company has developed beyond expectation on the 200-ft. level. A good vein of silver-lead ore running from $30 to upward of $100 per ton in gold, silver, and lead was unexpectedly discovered in driving for the east ore-shoot opened on the level above, after cutting through a heavy fault-zone. The strike has attracted more attention than any recent development in the Grass Valley district. At the Looby shaft of the company sinking continues on ore and shipments of ore taken from development continue to be made to the smelter. Preparation for sinking to the 300-ft. level of the

Rock Rose are under way and the work will be resumed in a few days.

At the Helena mine of the Helena Mining Bureau, in the same district, the shaft is being sunk on the vein to the 300-ft. level, and shipments are made as the ore comes up. Five shafts are in active operation in a small area in the Grass Valley district, with a sixth about to be started. All these operations are on ore and the outlook for a large and deep mining district is promising.

At the Scratch Gravel hills, the Julia mine has placed a steam-plant and is re-timbering the shaft. Shipments from this development, and from a small stope, have kept the Home syndicate, which is operating the property, in funds for development and equipment with something to the good. This is a gold producer. The shipping ore averages 1 oz. gold and a total of $28 per ton. Much milling ore carrying from $5 per ton gold, and upward, is in reserve.

Helena, May 6.

(Special Correspondence.)—The old Drumlummon mill, now controlled by the St. Louis company, has resumed operation and is running steadily and satisfactorily. This plant was equipped with electric-power during the past winter and changes have been made throughout for economy and greater efficiency. Ore from the old stopes and caves is being run. In the mine development is under way to reach known orebodies and to further prospect virgin ground. Two shifts were put on during the past week.

The Barnes King Development Co. had two of its best month's runs in March and April. Development in the Gloster mine of this company has given encouragement for the further development of new territory and has aided materially in the recent returns. At the company's Shannon mine the shaft has been sunk to the 500-ft. level, 300 ft. below the adit, and sinking has been resumed for the 600-ft. level. This mine continues to produce and develop well. An accident at the loading-terminal—a runaway bucket coming down the steep grade leading from the terminal—caused the serious injury of two men, but both are improving and will recover.

Deep snows have delayed much field work in this district, the condition of the roads being more than six weeks behind last year, itself a late opening.

On the Marysville Gold property, development continues on ore at several faces with a large tonnage blocked out, having an estimated milling value of $1,500,000. The principal development is east of and adjoining the Shannon, in the old Blue Bird mine. High-grade ore has been found in the Mt. Pleasant, north of the Blue Bird. This will be reached by the Blue Bird and Hickey cross-cut, now approaching this ore-zone. A heretofore unknown vein was recently cut in the Hickey cross-cut and driving east has been commenced on this. It lies in the course of the Spokane vein, under development on the north side of the mountain. If it proves to be the same, the development on the Spokane at 400 ft. greater depth will penetrate the south area between the two developed zones. No plans have as yet been made for installing a mill for these properties.

Lessees will start work on the Bell Boy, an early-day producer, as soon as snow will permit getting in. Surveys have been made and an adit will be run to tap the ore of the Gleason Fraction and the west end of the Bell Boy.

Marysville, May 6.

NEVADA

Esmeralda County

Eighteen inches of high-grade ore, yielding assays up to more than $500 per ton, is showing in the new drift above the 880-ft. level of the Jumbo Extension mine at Goldfield. This drift is being extended from an incline raise that was driven back into the Velvet claim of the Jumbo Extension from the workings of the adjoining Jumbo Junior, where the rich ore-shoot was discovered and where a carload of shipping-ore has been broken lately by the latter company. There is a good prospect of a steady production from this strike.

The rich ore is being broken separately, leaving the waste and ore of lower grade to be handled in the future.

Humboldt County

A new strike of gold ore is reported from National in the northern part of the county. According to the Lovelock *Review-Miner*, the strike was made on ground not previously located, on the west slope of Auto hill, down near the foot of the range. A shaft is being sunk on a vein 4 ft. wide that assays up to $80 per ton, mostly in gold. It is said to be at or near the contact of rhyolite-porphyry and a dike of latite.

Eighteen horses, hauling four heavy wagons and a trailer, are freighting antimony ore into Lovelock from the Antelope Springs antimony mine, in Coal canyon, a few miles east from here, says the Lovelock *Review-Miner*. The team is said to be the largest ever used in hauling ore in this vicinity, and is pulling 20 tons per trip.

The hauling will continue for several weeks, until enough ore to complete a shipment has been brought in. Although the destination of the shipment has not been announced, the ore is to be shipped to the Atlantic coast.

This is the first important antimony shipment from this part of the State since antimony dropped in price.

Three shifts are being worked on the Mazuma Hills mine, in the Seven Troughs district, under bond and lease to the Helen Betty Mines Co., that is also operating the Darby mill. Two shifts have been worked previously.

Reports coming from the property are to the effect that the rehabilitation and unwatering of the old property is well under way, and encouraging prospects are being found as the work progresses.

The old Darby mill has been put in good condition, and additions and improvements to increase its capacity have been made.

Lincoln County

Ore shipments are being made to the extent of about 250 cars monthly. The principal shipper is the Prince Consolidated. Other shippers are the Nevada Copper, Hamburg, Hodges-Cook, and Con. Nevada-Utah.

The Hamburg has declared a dividend of $8000, payable May 21. It is reported that another dividend will be paid in June. There is said to be $40,000 worth of ore broken in the stopes ready for shipment.

Nye County

(Special Correspondence.)—The development work on the third level in the White Caps has made average progress during the past week. The east drift has been extended 35 ft. The face is still in calcareous shale with some stringers of calcite showing. The west drift has made 37 ft. during this time. Some lime is showing although not in place, being drag from the faulted zone. The face of the west drift is still in faulted material. On the fourth level, the timbering of the sump has been completed. The new hoist has been installed on the station and everything is ready to commence sinking, as soon as shaft-timbers reach the mine. The hoist for the sinking is a 24-hp. electric, of Hendrie & Bolthoff type. Several needed improvements have recently been made in connection with the surface-plant. A Denver rock-drill sharpener has been placed in the blacksmith-shop. This machine will sharpen 100 drills in a half hour when operated at full speed. It is the intention of the management to purchase the steel in future, and make up the drills needed in the shop, as with the sharpener the drills can be made up in less time than it takes to sharpen a machine-drill by hand. The old transformer-house has been torn down and a new iron structure built around the transformers. A much needed safe-guard is an automatic circuit-breaker above the transformers, also put in. In case of a surge of current on the high-tension power lines, this circuit-breaker will protect the transformers from a short-circuit and

fire. Two cooling-tanks, with a capacity of 14,000 gal., to cool the water for the two compressors have been added to the surface equipment. These tanks are connected with pipe-lines and hose, so that adequate fire protection for the mine buildings is always ready. The centre column for the Wedge roaster has been put in place. The column is 25 ft. 5 in. high, 5 ft. diam., and weighs 14 tons.

Steady work in sinking the shaft has been progressing during the week at the Morning Glory. Good progress has been made, although some repairs to the hoist have delayed the sinking from being done at maximum speed. Two shifts are employed.

Development work from the 600-ft. level in the Amalgamated for the past week is as follows: The east drift has advanced 47 ft., making a total of 145 ft. The west drift advanced 23 ft. during the week, and is now out 119 ft. from the shaft. The south drift, in a fissure vein, is now out 19 ft. The raise on the fissure is up 10 ft. For 70 ft. the west drift is in mill-ore 5 ft. wide. The face of the drift is in solid ore. The fissure shows 3 ft. of ore averaging $20 in gold. The east drift is following a lime-shale contact.

At a meeting held May 2, which was attended by the local mine and mill-managers, of every property employing men in the camp, after thoroughly threshing out the pros and cons of the wages paid at Manhattan, a uniform wage-scale was adopted. The new scale is to go into effect not later than May 10. The scale is as follows: For miners in shaft-work, $5 per shift for hand-work, $5.50 for machine-work. Machine-men, $5; timbermen, $5; shovelers, $4.50; cagers, $4.50; pump-men, $5; timber-framers, $5.50. For surface employees, engineers, $5 per shift, with the understanding that if engineers also help to frame timbers, or to sharpen steel, that they be paid an additional 50c. per shift. An additional 50c. to be paid should engineers be employed in the operation of double-drum hoists. General blacksmiths are to be paid $5.50; tool-sharpeners, $5; blacksmith-helper, $4.50; machinist, $5.50; machinist-helper, $4.50; carpenters, $6; timber-framers, $5.50; ore-sorter, $4; top-men, $4; laborers, $4; electricians, $5; pipe-men and trackmen, $5. The scale for mill-employees will be announced later.

The first round in the cutting of the station at the 312-ft. point in the shaft at the Consolidated property was shot May 3. The bottom of the shaft is 320 ft. deep, the additional depth below the station being for sump. As soon as the station has been completed, a cross-cut will be extended, through the vein, then the shaft-sinking will be resumed to the 400-ft. level. At the point where the station is being cut, the shale is loose, with large fractures and full of quartz stringers. All indications point to the close proximity of the vein. Due to the fact that no water of consequence has thus far been encountered, it is believed that the inflow will be negligible, even after striking the vein.

Manhattan, May 8.

L. G. Burton, of Salt Lake, is at Ophir canyon in the Toiyabe range, 60 miles south of Austin, to commence operations on the old Murphy group of mining claims, which produced a large amount of silver ore in the '70's. This property is owned in Chicago and Mr. Burton and associates have a lease and option on the same. The new company will be known as the Nevada-Ophir. A great deal of work has been done on the property, which, considering the lapse of time, is in a fairly good condition for early production. Two shifts will be put to work and as the old workings are cleaned and opened up more men will be added to the force.

Storey County

The Comstock-Phoenix mine in the East Comstock district has shipped another car of high-grade ore to the Hazen sampler. The ore has an average value of over $300 to the ton. George H. Drysdale, the superintendent, states that the preliminary work is practically completed and sinking to greater depth will begin within a day or two. The winze is to be sunk an additional 250 ft. to the 800-ft. level, where extensive exploration will be carried on in the ground below the stopes that have yielded handsomely in the past. The present deepest level is the 550. This section of the Comstock has never been opened at great depth.

NEW MEXICO

Socorro County

(Special Correspondence.)—At the Pacific mine the 500-ft. level has been advanced 700 ft. north and the 600-ft. level is out 200 ft. in the same direction. A new vein, carrying copper, gold, and silver, has been cut in the southern part of the property. All of the old ore dump at the north end of the mine of sufficient value has been packed to the terminal-bins of the aerial-tramway to the Socorro mill and has been treated in the latter plant, and the dump at the south end is being disposed of in a like manner. In addition, stoping is under way above the adit-level.

The Oaks Company has increased its crew at the Maud S. mine and is shipping ore to the Socorro mill. Unusually good mill ore was found the past week.

H. J. Evans is starting work on the Iron Rule claim in the southern part of the district. The lower adit is to be advanced. It is on the same contact and much deeper than the Iron Bar claim, which has produced shipping-ore. For the amount of work done this section of the district is showing up favorably.

The Deep Down shaft has been re-timbered to the creek-level, a station put in, and bulkheads are now being completed. The shaft will be sunk to the 500-ft. level and drifts extended east and west. From this opening the Maud S., Eberle, and Clifton will be developed, as the shaft is centrally situated, making the plan an economical one for the exploration of the several properties, all of which are under control of the Oaks Company.

Mogollon, May 6.

OREGON

Jackson County

(Special Correspondence.)—Alfred Lewis, of Gold Hill, who has charge of the development of the Mountain King quicksilver mine, north of Gold Hill, reports that the richest ore yet found in the mine has been uncovered this week. Carey Edmonds, a miner employed in the mine, while off shift prospecting through curiosity, made the strike. He found very rich panning-dirt on the surface on the strike of the main vein, 1500 ft. east of the works. Digging down two feet from the surface, he struck the main vein, 15 ft. across, which averages 35% mercury. Four additional adits extending 100 ft. from the discovery along the vein shows the same grade of ore. It is reported that J. R. Hayes, of Detroit, Michigan, owner of the property, will have buyers on the ground in the next few days, who will also buy 300 acres of adjoining patented land, making a total of 900 acres.

Gold Hill, May 4.

UTAH

Tooele County

At present four mines are shipping from the Deep Creek district. They are the Western Utah Copper, Pole Star, Woodman Gold Mining, and Yellow Hammer. The Western Utah Copper, owning the old Glory Hill, has been shipping as much as 200 tons daily. The heaviest single day's production was 250 tons. The Pole Star has been shipping some of its best grades, and the Woodman making occasional shipments. Dutch mountain and Erickson districts are about to begin shipments.

In the camp of Ferber, 10 miles to the west, reached from Erickson's Ranch station, several properties are in shape to ship on a small scale. The Ferber Copper has been shipping, while some of the old properties are said to have good grades of copper ore broken and blocked out that should stand ship-

ping now that the railroad is within a dozen miles, with a good wagon-road between.

N. A. Dunyon of the Western Mines Development Co. has gone to Ferber to take charge of that property, which embraces the old Big Chief. It is expected that this company will join the shipping list shortly.

JUAB COUNTY

The Chief Consolidated Mining Co. for the first quarter of 1917 reports as follows:

Work and production at the mine:	
Drifts, feet	3368
Raises, feet	469
Total, feet	3837
Pinyon Peak Tract:	
Drifts, feet	924
Plutus Mining Company:	
Drifts, feet	270
Total of all development work:	
Drifts, feet	4562
Raises, feet	469
Total, feet	5031

The total shipments of ore were 19,566 tons (dry) yielding net after the payment of smelting, transportation, and sampling charges, $451,616.40.

Metal contents:	
Gold, ounces	2,690
Silver, ounces	406,199
Lead, pounds	4,232,335
Zinc, pounds	93,260
Zinc-lead ores:	
Zinc, pounds	90,511
Lead, pounds	66,170
Assay value:	Per ton
Gold, ounces	0.1375
Silver, ounces	20.76
Lead (on lead ores), per cent	13.888
Zinc (on zinc ores), per cent	39.85
Zinc-lead ores:	
Zinc, per cent	20.29
Lead, per cent	14.83
Average gross value, per ton	$36.99
Smelting, freight, and sampling, per ton	13.91
Average net value, per ton	$23.08
Net profit after the payment of all charges	$202,435.28
Classified tonnage:	Dry tons
Lead ore	15,237
Dry ore	3,989
Zinc ore	117
Zinc-lead ore	223
Total	19,566

WASHINGTON

STEVENS COUNTY

The Chloride Queen group of mining claims on Clugston creek 12 miles north of Colville are to be developed this year. It is reported that a concentrating-plant of from 50 to 100 tons capacity will be built at a cost of about $20,000.

MEXICO

CHIHUAHUA

The Santa Gertrudis Company, Ltd., reports for March as follows: Ore milled, 19,549 tons; estimated profit, £7853.

KOREA

The clean-up for March of the Oriental Consolidated Mining Co. was $147,705.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

D. M. RIORDAN is at Hanover, New Mexico.

L. B. NEWBY of New York is in San Francisco.

HOWARD D. SMITH has returned from New York.

THOS. H. LEGGETT has been examining mines at Butte.

KWONG WA, a mining engineer with the Ministry of War, is in San Francisco from Peking.

R. E. ADAMS, formerly at Velardeña, Mexico, is at Park City, Utah.

FRANK W. OLDFIELD has returned from New York, on his way to Jalisco, Mexico.

LEWIS E. FOSTER has opened an office as consulting engineer at Gila, New Mexico.

RALSTON WILBUR, mining engineer, has joined the Officers' Reserve Corps and is at the Presidio.

F. L. THOMAS, manager of the Leonesa mine, in Nicaragua, is here on his return from New York.

M. H. KURYLA has received an appointment with the U. S. Smelting Company at Silverton, Colorado.

FRED. HELLMANN sailed for Chile, going to Chuquicamata, on May 5, and expects to return in September.

HENRY H. ARMSTEAD is president of the Armstead Mines (Inc.) operating the Keystone mines on Lake Pend Oreille, Idaho.

ERNEST WITTERNAU has been appointed assistant superintendent of concentration for The Arizona Copper Co. (Ltd.), at Clifton and Morenci.

FRANCIS S. SCHIMERKA has been appointed research engineer for the milling department of The Arizona Copper Co. (Ltd.), at Clifton and Morenci.

F. K. BRUNTON, formerly metallurgist and assistant superintendent of the British Columbia Copper Co., is now superintendent of the Consolidated Arizona Smelting Company.

FOREST B. CALDWELL has returned to San Francisco from Manhattan, where he has been elected a director and retained as consulting engineer for the Morning Glory Company.

PHILIP N. MOORE, president, and BRADLEY STOUGHTON, secretary, of the American Institute of Mining Engineers, are making a tour of the West. They were the guests of the San Francisco section at a dinner and meeting on May 7.

Obituary

A. M. DAY, metallurgist at the International smelter at Tooele, Utah, died in Salt Lake City, May 2. He was born at Minneapolis, May 9, 1865. At one time he was superintendent of the Butte & Boston smelters at Butte, and also was for some time superintendent of the Yampa smelter.

GEORGE E. AMES died in San Francisco on May 11, at the age of 78 years. Mr. Ames was identified with the industrial development of San Francisco to a large degree, having been for many years in charge of the mining machinery department of the Union Iron Works. Many of the largest installations of milling, hoisting, and pumping-machinery in California, Nevada, and Montana were made under his supervision. In 1898 he resigned his position with the Union Iron Works to become chief engineer for the Anaconda Copper Mining Company on the solicitation of the late Marcus Daly. Following this engagement, he became Pacific Coast representative for the Allis-Chalmers Company, and later, consulting engineer for the Mascot Copper Company, afterward retiring to private life.

THE METAL MARKET

METAL PRICES

San Francisco, May 15

Antimony, cents per pound	23
Electrolytic copper, cents per pound	37
Pig lead, cents per pound	9.75—10.75
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$106
Spelter, cents per pound	12
Tin, cents per pound	65
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, May 15

Antimony, 50% metal, per unit	$1.65
Chrome, 40% and over, f.o.b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tungsten, 60% WO_3, per unit	20.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 45% (under 35% metal not desired), cents, unit	36—38

On this page in the issue of May 5 the content of merchantable manganese ore was stated in terms of MnO_2. This was an inadvertence, and occurred only in that one issue. Settlement for manganese ore is always made on the basis of the percentage of the metal contained, and not on the amount of di-oxide.

Manganese prices and specifications, as per the quotations of the Carnegie Steel Co. schedule of prices per ton of 2240 lb. for domestic manganese ore delivered, freight prepaid, at Pittsburg, Pa., or Chicago, Ill. For ore containing

	Per unit
Above 49% metallic manganese	$1.00
46 to 49% metallic manganese	0.98
43 to 46% metallic manganese	0.95
40 to 43% metallic manganese	0.90

Prices are based on ore containing not more than 8% silica nor more than 0.2% phosphorus, and are subject to deductions as follows: (1) for each 1% in excess of 8% silica, a deduction of 15c. per ton, fractions in proportion; (2) for each 0.02% in excess of 0.2% phosphorus, a deduction of 2c. per unit of manganese per ton, fractions in proportion; (3) ore containing less than 40% manganese, or more than 12% silica, or 0.225% phosphorus, subject to acceptance or refusal at buyer's option; settlements based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken to be deducted from the weight Prices are subject to change without notice unless specially agreed upon.

Tungsten: Foreign business that was placed last week has helped to eliminate quite a tonnage of ore, again reducing the Eastern stock to an absolute minimum. No high-grade ore of any kind is to be had in quantities. Shipments from the West are delayed an account of difficulties in securing railroad cars, and though quite a number of manufacturers have contracted for ore at comparatively low prices, they are now forced to come into the open market and this has accentuated the position to such an extent that high-grade ore has been paid for at the new schedule prices.

EASTERN METAL MARKET

(By wire from New York)

May 15.—Copper is quiet but firmer at 32c. Lead is strong and scarce at 10.50c. Spelter is dull and steady at 9.37c. Platinum is quoted at $105 to $110.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
May	9	Apr. 3	34.58
"	10	" 10	33.83
"	11	" 17	32.75
"	12	" 24	31.47
"	13 Sunday	May 1	30.43
"	14	" 8	31.37
"	15	" 15	32.00
	32.00		

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	33.16	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
May	9	Apr. 3	72.98
"	10	" 10	73.72
"	11	" 17	73.27
"	12	" 24	74.08
"	13 Sunday	May 1	74.06
"	14	" 8	74.92
"	15	" 15	74.69
	74.62		

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	72.51	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

The weekly circular letter of Samuel Montagu & Co. of London, of April 19, says: On April 5 the quotation receded to 36⅝d., and remained either at that figure, or 1/16 lower until yesterday, when a change came over the market in sharp contrast to the apathy of the preceding fortnight.

Supplies of silver for some time have been scarty—a fact of little moment so long as demand kept small and fitful. Recently some China purchases, covering bear sales or otherwise, set in and the market was not broad enough to fill the demand.

It is understood that the United States government made further purchases last week, and the paucity of offerings from that quarter encourages the idea that coinage requirements for the States are likely to be a factor of some importance. In these circumstances much expansion of American supplies, even at advancing prices, can hardly be expected.

Continued pressure to buy upon a starved market may possibly carry the quotation to a figure more tempting to speculative holders, the number and holding of which have assumed modest proportions; or to a level at which China sales of some magnitude will become profitable.

The Indian currency return for April 15, as given below in lacs of rupees, shows a reduction of 62 lacs in the holding of silver, although the total of the note issue has increased by 37 lacs.

	Apr. 7	Apr. 15
Notes in circulation	8410	8447
Reserve in silver coin and bullion	1736	1674
Gold coin and bullion in India	1158	1219
Gold in England	667	592

The stock in Bombay consists of 1700 bars, as compared with 1900 bars last week.

The stock in Shanghai on April 14, 1917, consisted of about 28,000,000 oz. in sycee and $16,400,000, as compared with about 30,600,000 oz. in sycee and $16,700,000 on March 31, 1917.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
May	9	Apr. 3	9.40
"	10	" 10	9.35
"	11	" 17	9.35
"	12	" 24	9.43
"	13 Sunday	May 1	9.62
"	14	" 8	9.93
"	15	" 15	10.49
	10.50		

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	9.38	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date		Average week ending	
May	9	Apr. 3	10.71
"	10	" 10	10.64
"	11	" 17	9.87
"	12	" 24	9.58
"	13 Sunday	May 1	9.23
"	14	" 8	9.61
"	15	" 15	9.37
	9.37		

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	10.20	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Date		May	1 113.00
Apr.	17 115.00	"	8 113.00
"	24 113.00	"	15 106.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	114.50	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	..
June	90.00	74.70	....	Dec.	123.00	80.00	....

Quicksilver has taken a drop of $7 per flask, to $106, since May 8, at which time it was $113. There is no particular cause to assign for this lower price, as the market is normal.

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	48.25	51.49	55.63	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Tin is higher than in many years, the prices mounting from day to day. On May 10 the price in New York was 64c. per pound.

Platinum is quoted at $105 for soft unalloyed metal and $110 for the hard natural platinum-iridium alloy.

Eastern Metal Market

New York, May 9.

Nearly all the metals show a stronger tone, especially those which were weak and dull very recently. More clarity is felt, though nothing is known definitely, regarding the probable policy of the Government as to its purchases and the price, especially as manifested in the recent sale of spelter, which is discussed below.

Copper is firmer with a strong tone and more business is reported than in some time past.

Zinc is not active and sales are few, but the tone is steady and firm.

Lead is stronger and higher, almost with each day. Sales the past week have been of fair volume.

Tin continues to advance and sentiment is bullish as to the future.

Antimony is the only weak metal on the list, having declined decidedly.

The steel market continues its strong tone and prices do not stop their advances, especially pig-iron. The trade is putting forth every effort to meet Government requirements as fast as they develop. Reports from Washington, that an outlay of $1,000,000,000 is contemplated for ships, is termed hysterical and the suggestion that the products of every steel-mill in the country be diverted to Government uses is not taken seriously in well-informed circles.

COPPER

A more cheerful tone pervades the market on the more general conviction, based on fairly reliable sources of information, that the large purchases probably to be made by the United States and its Allies will not go at 16¾c., but at a price nearer the market. Some place it at 25 to 27c. per lb. and an estimate of the combined needs is put at 1,250,000,000 lb. This is regarded as high in some quarters. Deducting this estimate from the probable output of this country for 1917, of 2,300,000,000 lb., only 550,000,000 lb. is left for ordinary domestic use, after the Allies' purchases early this year are taken into reckoning. At any rate, the market is stronger and demand is better. A steady business has been done lately. Sales of fairly large proportions were made last week for third-quarter delivery at about 29c., New York, which is the quotation for that position. Sales for June delivery have been made at 31c. These transactions are believed to have been confined to a few large consumers. The market as a whole is more cheerful with the bogey of a two-priced market removed, probably as an unsettling factor. The London quotation for spot electrolytic yesterday was £142, unchanged from last week. The quotation in New York, yesterday, for both Lake and electrolytic for spot delivery was 32 cents.

LEAD

Lead grows scarcer and the market stronger almost daily. Many large producers have withdrawn from the market pending the Government's decision regarding its actual wants and the price it will pay. It is reported that 2500 tons was sold during the last week to the Government for May-June delivery, but the price is a secret. This is regarded as relatively inconsequential as compared with the ultimate needs which will probably be large from July 1. The American Smelting & Refining Co. advanced its price ½c. per lb. to 9.50c., New York, on May 2, but with no immediate effect on the market. Sales have been made in the week at all prices, 9.50c., New York, 9.75c. for June shipment with May shipment from St. Louis at 10.50c. Yesterday June, delivered New York, went at 10.50c., with prompt shipment from the West at 10.40c. The quotation yesterday for early shipment was 10.45c., New York.

ZINC

A bullish factor, but one of little driving force just at present, has made its appearance in the official announcement of prices for metal to be furnished the Government. The zinc committee of the Council of National Defense has come out with a statement that for grade A spelter 11½c. per lb.; for grade B, 11c. per lb., and for grade C, 9c. per lb., all delivered, will be the ruling price, with the latter one protected against a decline. The significant fact is that the 9c. price is so near the market, that it puts to sleep the rumors of much lower official prices, which have been so disturbing. At these prices 25,000,000 lb. have been contracted for; but the Government purchases will be increased later. Business at present is very quiet and sales are few. Some buying is reported this week at 9.12½ to 9.25c., St. Louis, or 9.37½ to 9.50c., New York, which is regarded as the quotation, but the demand is small. The July price is pegged at 9c. by some.

ANTIMONY

The market has experienced a sudden decline. From a quotation of 32 to 32.50c. a week ago for prompt Chinese and Japanese grades, the metal was obtainable yesterday at 24 to 26c. The cause is the unexpected offering of two lots of overland shipment which met a dull market. It was not due to the fact that "shrapnel had gone out of style," as one dealer put it.

ALUMINUM

There is no change. Russia is buying large quantities of scrap-metal and absorbing anything that is pure enough, whether virgin metal or not. The quotation for No. 1 virgin aluminum is 59 to 61c. for early delivery, New York.

TIN

The market has developed a very strong tone with prices advancing almost daily. From a price of 58.25c., New York, on May 2, the quotation has risen to 58.50c., on May 4, to 59c. on May 7, and to 59.37½c. yesterday. In the past week sales of about 800 tons have been reported, a large part futures, but now sellers are more disinclined to sell despite a good demand. The first four days of the month the market was dull, though on May 3 there was a little activity with sales of 200 tons, mostly futures. On May 4 less than 100 tons was purchased. The best demand in a long time developed on Monday, May 7, when 250 to 300 tons was sold, but probably by only a few sellers. At present very little spot metal is available. More business could be done were sellers willing to part with their supplies. The dominating factor in the market is ships enough to bring the metal to this country. Without doubt mutually satisfactory arrangements will be entered into between this country and Great Britain to insure permits to ship enough metal to supply our needs. Arrivals for May to the 8th were 1000 tons, with the quantity afloat at 425 tons. The London quotation for spot Straits was £232 12s.6d., an advance of over £2 above last week.

ORES

TUNGSTEN. High-grade ore is reported scarce, due partly to sales in the past week of quantities, pending a week ago, for foreign consumption. Not much ore is reported sold at the new schedule of $20 for 60% concentrate, though fair quantities have gone at $17 to $19 per unit, New York. Ferro-tungsten is quoted at $2 to $2.15 per lb. of contained tungsten and there is good foreign demand from Italy and France for this and the ore.

MOLYBDENUM. The market is very quiet and dull, with the last quotation on molybdenite at $2 per lb. of MoS_2.

ANTIMONY. There is no change since the report a week ago with the market lifeless.

Company Reports

PITTSBURG-DOLORES MINING CO.

Following is a resumé of operating expenses at Rockland, Nevada, for the period ended November 30, 1916.

Total time, 18 months from the starting of operations.

TONNAGES AND VALUES

	Per ton	Total value
23,326 tons mine rock	$9.26	$215,972.91
2,052 tons old dumps	4.00	8,208.00
337.17 tons tailing	2.82	951.10
1,097.48 tons tailing	2.75	3,021.96
456 tons tailing	4.86	2,215.69
Total		$230,369.66

The first two lots of tailing listed were from the old leaching-plant, and the last lot was from the old stamp-mill dump. Most of the old dumps were washed away by heavy rains during the last twenty years and the amount treated was only what had remained.

When the mine was sampled the average value of the mine-ore was calculated at $9.40 per ton. It will be noticed that the ore produced averaged $9.26 per ton or 14c. less than the estimated value. The mine costs were as follows:

	Per ton
Cost of mining	$1.93
Cost of development	0.92
Miscellaneous	0.42
	$3.27
Tramming to mill	0.23
Total cost	$3.50

The tram is 1800 ft. long from the mouth of the tunnel to the mill.

During the period a total of 2900 ft. of raising was done at an average cost of $3.16 per ft., and 2150 ft. of driving at a cost of $4.62 per ft. The amount of driving was low as compared to raising, as the adits had been extended for long distances without raising between levels during the period of re-opening the old workings.

There were 26,609.06 tons of tailing discharged of a total value per ton of $0.814. Extraction was 90.4%. The average cost of milling was $2.75, but the costs were reduced from $3.20 during the first six months, to $2.28 during the last six months, notwithstanding continual increase in the price of supplies. This was brought about by mechanical improvements and metallurgical saving. It was also caused by the increase in the ratio of gold to silver in the ore which permitted a better extraction and also materially decreased the period of treatment. The bullion is now worth $3.52 per oz. In January 1916 it was $2.15 per oz. Only a small portion of the increase is caused by the present value of silver.

The average tons milled per day was 49. This was increased to 60 tons during last year. Assaying, office, and general expenses averaged 73c. per ton; $18,748.95 was spent for construction.

Supplies increased in cost from 12%, for some minor items, to as high as 220% during the period. The increase is estimated at 68c. per ton for the period over the prices that prevailed when operations were started in the summer of 1915. There were $6430 worth of supplies on hand November 30, 1916.

Owing to the lack of sufficient water in the district with which the treatment of a larger tonnage would be possible, the installation of a filter is recommended. At present two sets of rolls are used and the treatment of a larger tonnage with satisfactory results being impossible with these, the purchase of a ball-mill to replace the rolls, screens, and elevator is also recommended.

It is estimated that a saving of $1200 per month can be made on the basis of 80 tons milled per day. Development in the mine has been limited to the old workings which were partly re-opened.

In the winze below the lowest adit some new work has opened up a new ore-shoot for 250 ft., and an average value of $12 per ton. Another long ore-shoot, averaging $8 per ton, was opened up on the 2nd level and the quartz in this has been found very satisfactory for tube-mill pebbles.

The location of the mine is 27 miles south of Yerington, Nevada, in Mineral county.

E. J. Schrader is manager, J. B. Perry, is mine superintendent, and C. R. Olson, mill superintendent.

TOUGH-OAKES GOLD MINES, LIMITED

The annual report of the Tough-Oakes Gold Mines, Limited, for the year ended December 31, 1916, is as follows:

Bullion shipments		$ 611,884.23
Bullion, slag, and matte on hand	$19,121.30	
Bullion, slag, and matte in transit	78,086.51	
Gold in process	2,533.42	
		99,741.23
		$ 711,625.46
Less marketing expenses		4,510.70
Total earnings		$ 707,114.76

OPERATING EXPENSES

Mining:		
Development—Driving	$46,599.60	
" Raising	11,591.37	
" Sinking	23,510.74	
Stoping	97,645.44	
Exploration—Cross-cutting	10,914.76	
Dumps and surface handling	4,221.57	
Hoisting	19,732.67	
Surface prospecting	67.24	
		$ 214,283.39
Reduction in broken ore reserve during year		17,093.75
Total mine operation		$ 231,377.14
Milling:		
Hoisting	$ 2,706.25	
Crushing and conveying	6,989.47	
Ball-milling	14,016.43	
Tube-milling and classification	19,480.23	
Amalgamation	216.26	
Cyanide treatment	28,415.67	
Precipitation	16,066.34	
Melting and refining	2,300.55	
Heating and watchmen	5,975.45	
Residue dam	522.23	
Total mill operation		96,688.88
		$ 328,066.02
Depreciation on buildings, machinery, and equipment		47,708.51
Total operating expenses		$ 375,774.53
Operating profit		$ 331,340.23

There are seven veins on the property on which little work has been done, and profiting by the experience gained during the past four years operations there is a reason for the belief that many new orebodies will be opened up after ample electric power is available for the full operation of the mine.

INDUSTRIAL PROGRESS

Dredging in the Arctic Region

The natural conclusion would be that dredging would not be practicable in the Arctic region during the long winter months, but such is not the case, for gold dredges work in the Klondyke region winter and summer, with little more loss of time, if any, than dredges working the year around elsewhere. Seven miles from Dawson, the Klondyke Mining Co. is operating a number of dredges, all of which, after steady operation in 1916, ran well into the winter, but were closed down in their turn for needed repairs. The largest and newest of this company's dredges is the Canadian No. 2. This boat has run without interruption since starting up in the spring of 1916. At times during the past winter the temperature was 60° F. below zero, but the dredge continued through it all without stopping. The machinery is driven by electric power generated on the north fork of Bear creek, and the dredge is heated throughout by steam, it being necessary to keep all parts of the machinery warm. Joseph W. Boyle, chief engineer, and acting general manager says of the work that preparing last summer for winter work they were enabled to give the dredge a favorable strip of ground for the winter period. All trees, stumps, sticks, and other obstructions that might encumber the dredge-pond and the operation of the dredge were removed during the warm season. The water from the river was turned aside so that it ground-sluiced a long channel, and permitted the water to percolate freely in that area of gravel. The dredge is not operating where the ice or other matter breaks loose into the river. Dredge No. 4, which shut down several days ago, operated in the main river toward the last. But it was found difficult to work in the centre of the river in winter. Some thought the ice would break off and go under the regular covering of ice on the river and wash away, but it was found that the broken part soon clogs, accumulates, and backs up, so as to become a serious interference to the dredge occupying the river position.

By operating the dredges as long as possible in the winter, and making the repairs in rotation in winter time, the fleet will be ready for operation next summer. Formerly the repair work was done entirely in the spring. That required an extra large crew of men engaged temporarily. By the new system the dredge-crews are employed constantly with little change in the number of men employed.

The following table from the company's records shows the operating-time during December 1916 and January 1917 by dredges No. 2 and 4:

	Operated hr.	min.	Lost hr.	min.	Operated %	Lost %
Dredge No. 2:						
December	666	09	77	51	85.54	10.46
January	661	39	82	21	88.93	11.07
Dredge No. 4:						
December	674	52	69	08	90.71	9.29
January	524	13	38	47	93.11	6.89
Total	2526	53	268	07	90.41	9.59

Canadian No. 2 is the largest dredge in the world, and has a capacity of 10,000 to 12,000 cu. yd. per 24 hours. It was made by the Marion Steam Shovel Co. During the winter months a crew of 29 men is required. George Monroe is dredge-master.

The accompanying illustration shows the Canadian No. 2 at work amid ice and snow on Bear creek, Yukon Territory.

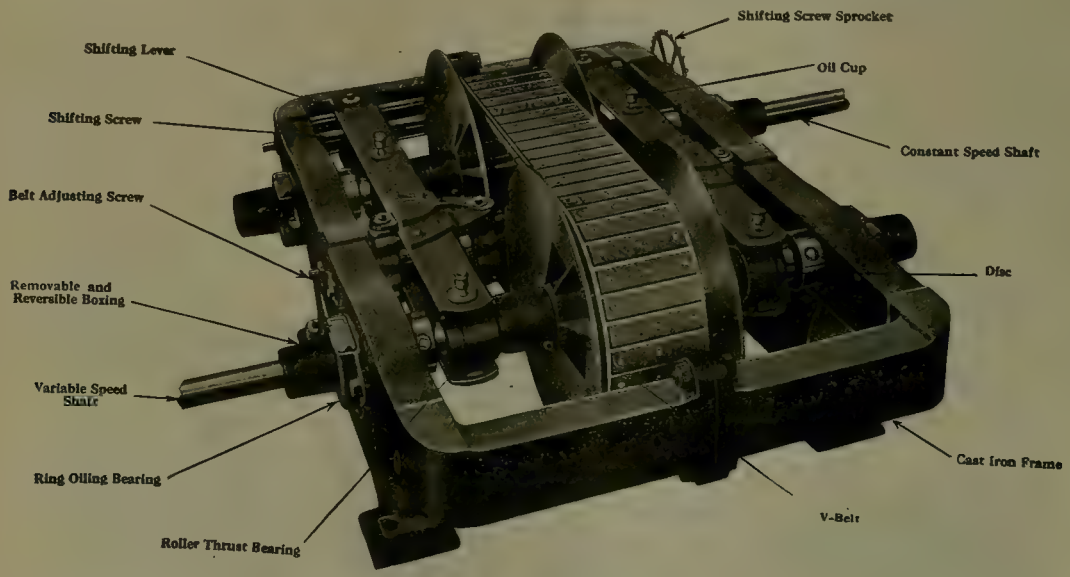
CANADIAN NO. 2 DREDGE OF THE KLONDYKE MINING CO., BEAR CREEK, YUKON TERRITORY

The Reeves Variable-Speed Transmission

This device is intended to control accurately and sensitively the speed of any machine it drives.

It may be installed on the floor or on the ceiling in the same manner as an ordinary counter-shaft.

One of its shafts, designated in the accompanying illustration, as the 'constant-speed shaft,' is belt-connected to the line-shaft, motor, or engine-pulley, whatever may be the source of power. The other shaft, designated as the 'variable-speed shaft,' is similarly connected to the drive-pulley on the machine to be operated.



THE REEVES VARIABLE-SPEED TRANSMISSION DEVICE

On each of these shafts is mounted a pair of cone-shaped discs. These discs are splined to admit of lateral movement, but rotate with the shaft. A special belt with leather-tipped wooden blocks drives on the edge against these discs. The outside disc of each pair is actuated in its lateral movement by a lever, pivoted in the centre.

The levers are actuated simultaneously by a right and left screw, so that as one set of discs closes, the other opens; with the result that the driving-belt, while assuming an increased driving-radius on one pair of discs, at the same time operates at a correspondingly smaller diameter on the other. This enables the variable-speed shaft, and the machine driven by it, to be operated at any speed within the range of its extremes of variation, which may be as high in ratio as ten to one.

The transmission is manufactured in 14 different sizes, from 2½ hp. to 150 hp; and in ranges of variation from two-to-one to ten-to-one.

In mining operations it is used on conveyors, concentrators, experimental machinery, fans, pumps—indeed, on any piece of machinery which it is desired to run at varying speeds; and by its use, these speeds are under the immediate control of the operator.

The Reeves transmission is manufactured by Reeves Pulley Co., Columbus, Indiana.

Commercial Paragraphs

R. H. Officer & Co. announces that with the change of management, by which Frank A. Bird took charge of the office, in addition to the work, including controls and umpires, as well as the assaying of hand-samples, mine, mill, and smelter products, ores, metals, and alloys, the company is prepared to take care of all classes of electrolytic work, together with the analysis of flotation-oils and re-agents; coals and cokes; iron and steel.

The Louisiana Consolidated Mining Co. has received two more new Duplex auto-trucks which will be used to haul fuel-oil and supplies from Tonopah to its Tybo mine, back-loading with high-grade ore. The first truck has been in service since March 1, and has given excellent satisfaction. The truck carries three and one-half tons, and the trailer, which goes with each truck, carries an equal weight.

Catalogues Received

The Monthly Bulletin of A. Leschen & Sons Rope Co. for April, is as usual, an interesting contribution to the varied uses to which their ropes are put in the mines, in logging camps, in building construction, on dredges, and elsewhere.

The Allis-Chalmers Manufacturing Co. has issued an attractive and useful bulletin, No. 1632, of its series, descriptive of the centrifugal pumps made by that concern. It is well illustrated and also contains considerable engineering data of value.

The Sullivan Machinery Co.'s bulletin No. 75-B illustrates the Sullivan straight-line air-compressor, with simple steam and two-stage air cylinders. It also describes and illustrates the Sullivan WB-2 air-compressor, a machine on a solid heavy box-shaped casting, which runs the full length of the compressor, thus insuring perfect alignment. This machine has several admirable features, among which is the intercooler, the tubes of which are made of copper or aluminum.

The National Pipe Company's Bulletin No. 27, is one of the most interesting and valuable of the numerous publications issued by that progressive concern. It contains 51 pages of handsomely illustrated descriptive text, showing the many uses to which National pipe has been adapted. There are also numerous valuable tables of use to engineers and others desiring accurate information regarding such matters as the weight of standard pipe of various kinds and sizes; the properties of pipe, with formulas; compressive strength of pipes, and bending-moments.

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Edited by T. A. RICKARD

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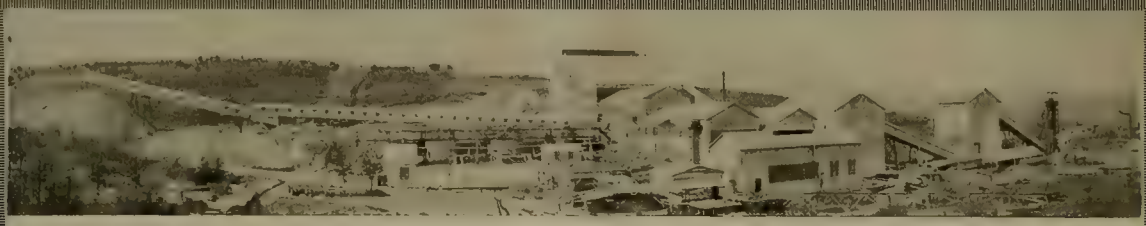

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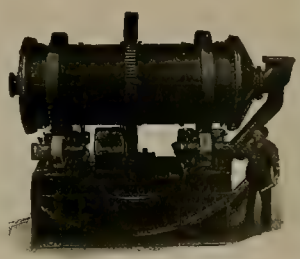
The American Institute of Mining Engineers

recently discussed a report of the competitive test made at one of the largest Copper Mines in Arizona by Mr. F. C. Blickensderfer which showed the efficiency of the MARATHON Mill to be several times greater than that of the other mills in the test, and it was agreed by many present to be an epoch-making improvement in crushing practice.



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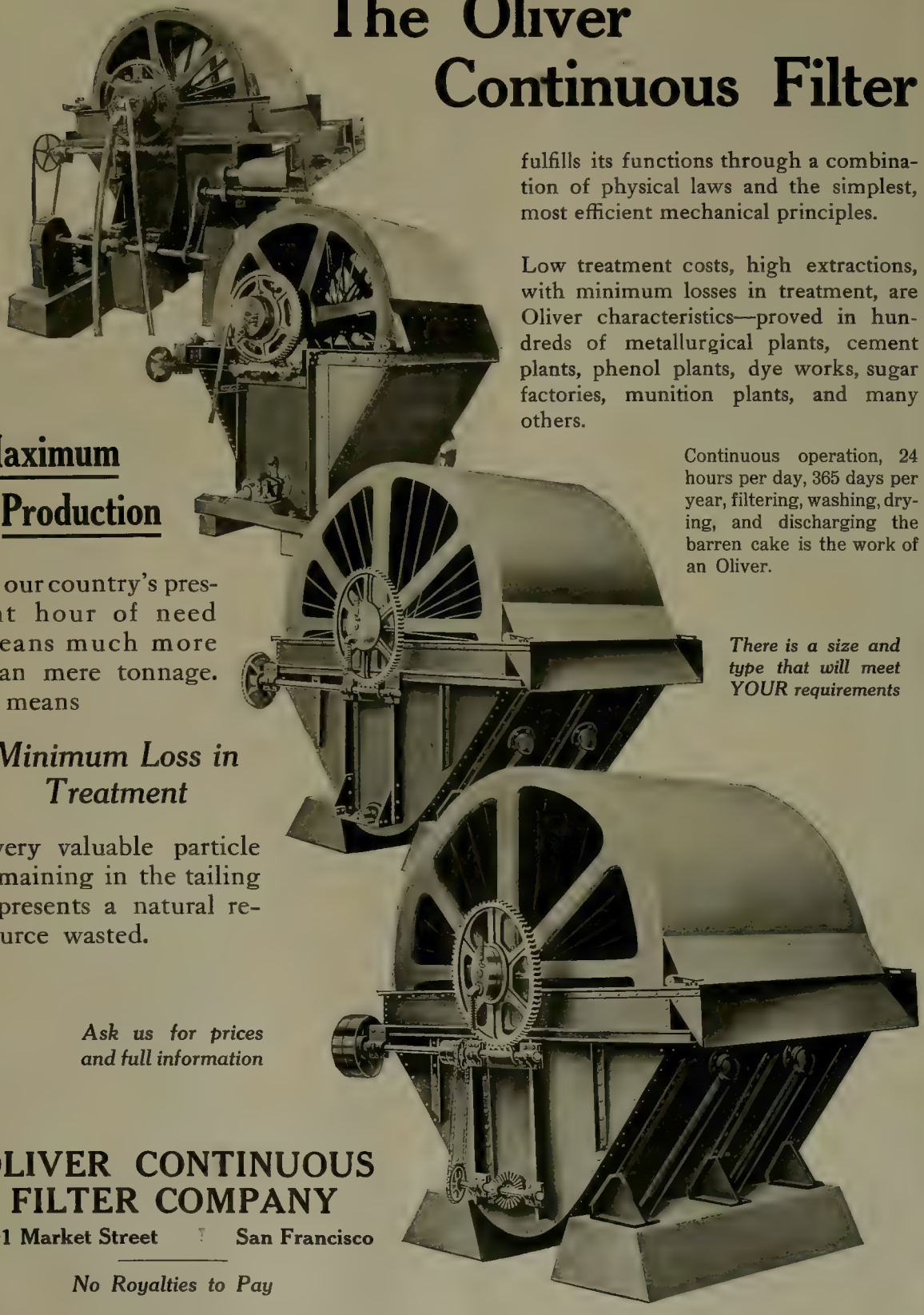

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EDITORIAL

T. A. RICKARD, Editor

THE ALUMNI of the College of Mining of the University of California gathered at a banquet at the University Club in San Francisco on May 15, and effected a permanent organization, with Prof. A. C. Lawson as president and *ex officio* chairman of an executive committee that will continue to direct the activities of the association and arrange for future meetings. The alumni of the College of Mining now number 536, widely scattered throughout the world. It is difficult to keep trace of the graduates, and one object of the organization is to maintain a directory, partly to facilitate communication with engineers in answer to demands for the services of capable men. The secretary of the association is Mr. L. C. Uren.

MAGMATIC segregation is again to the fore in this issue, a general critical review of the subject being presented by Dr. Joseph T. Singewald, Jr., of Johns Hopkins University. He points out that the theories of the French school of economic geologists have received fresh confirmation by the studies recently made by Dr. C. F. Tolman, Jr., and Prof. Austin F. Rogers, of Stanford University. The evidence that the ore-minerals replace the silicates without forming metallic silicates, and that mineralizers were active in the formation of ore deposits of the character known as magmatic segregations, not only has been sustained by Tolman and Rogers, thus confirming De Launay, but is further corroborated by independent investigations made by Dr. Singewald upon a large number of titaniferous iron-ore deposits in the United States and elsewhere.

TAXATION of mining claims has commonly been assumed not to be permissible until the title had passed from the United States to an individual. This opinion is so widespread, and the failure to assess unpatented claims for purposes of taxation has been so nearly universal, as to give the sanction of custom to such exemption. Nevertheless the laws of California and of some other Western States have taken account of the possibility of deriving revenue from this source, and the possessory right of the locator is made amenable to a tax-demand. Cases have been decided by the Supreme Courts of the United States and of the State of California, holding that the possessory interest in public mineral lands acquired by location is subject to taxation by the State and its municipal subdivisions as real property. Only this possessory interest can be sold under a tax-sale, and the purchaser must perform the annual labor, otherwise the ground is again open for location. The same ruling applies to quarries and to timber belonging to individuals or corporations on the lands of the United States.

CHILEAN exports of sodium nitrate to the United States last year increased to about double the usual amount, reaching a total of 1,067,000 tons. Copper importations from Chile have a little more than doubled since 1913. It is noteworthy that our demand for Chilean iodine has been sharply emphasized, resulting in the importation of 1,044,000 pounds whereas the importations in normal periods seldom reached 300,000 pounds. The value of the iodine has risen likewise from $1.34 to $2.34 per pound, while the price of sodium nitrate has remained stationary, the prices in 1913 and 1916 respectively being $33 and $29.10 per ton. It is now announced that the United States government has arranged for the importation of $10,000,000 worth of Chilean nitrate, and deposits of large extent in the province of Tarapacá have been acquired by Du Pont de Nemours & Company, which indicates that this great powder-making corporation fails to see possibilities of speedily supplying our needs for fixed nitrogen by the available electric processes and by an increase in the output of ammonia from by-product coking. At the same time important research-work by the Semet-Solvay Company on the oxidation of ammonia to nitric acid has resulted in setting apart its plant exclusively for Government service.

DISCUSSION this week is enriched by an account of work performed at Broken Hill, Australia, by Mr. W. E. Simpson, from which the conclusion was reached that flotation by the Potter process was dependent in part upon the formation of gelatinous silica adhering to the minerals of metallic lustre and forming them into aggregates by coagulation. The suggestion that the presence of flourspar was also essential in this case through the evolution of hydrofluoric acid in the reaction between that mineral and the sulphuric acid, thus producing in the pulp a reagent that would liberate silica in colloidal form, is another point of interest. Mr. W. Tovote contributes an important note on the catalytic effect of native copper in promoting the reduction of more copper from sulphate solutions, building up crystal aggregates of the metal. He also adduces reasons for suspecting that chalcanthite may be altered into native copper, pseudomorphic after that mineral, in the presence of reducing agents in shale. Mr. F. H. Mason cites another example of large concentrations of nitrogen in rocks, and Mr. Fred T. Greene announces a precedent established in the case of one railroad for accepting an engineer's mine-samples as baggage.

Tin and Glass

Tin has given the Government considerable uneasiness. The price has risen from 55 to 65 cents per pound within the last three weeks. Insufficiency of the metal to meet recent demands is probably reflected with accuracy by these quotations. The shortage may be due in part to the uncertainties and difficulties of transportation. Some incline to the belief that the trouble is more fundamental, and intimate that an actual diminution is noted in the tin output from the Far East. Whatever the explanation, tin-stocks are low in comparison with apparent needs, and the Department of Agriculture has seen fit to advise the canners to desist from packing imperishable foods, such as peas, beans, and hominy, in tin-plate containers. Some lack of proper organization was thus disclosed. It turned out that the alarm over the scarcity of tin was based upon reports which the manufacturers of cans had sent to the Department giving estimates of the needs for putting up this season's crops, according to requisitions received from packers throughout the country. At this point official action was taken to conserve the supply of tin-plate, and the canners replied that the only fair procedure would be to make the restrictions obligatory upon all packers, otherwise compliance on the part of some would merely operate to benefit those competitors who might disregard the request made by the Secretary of Agriculture. It is now stated by the leading manufacturers of tin cans that the original estimates of the season's needs were too high; that many packers, fearing a *pro rata* reduction of the allowance of containers, had asked for three to four times as many cans as they actually expected to use, and in consequence the American Can Company has just notified its customers that they can furnish all that may be legitimately needed. If this be the case, there should be a sympathetic response by a slump in the tin market. It must not be overlooked, however, that Eastern packers have taken the reported shortage of tin-plate seriously, and the demand for glass jars has become so great that the glass-makers are six months behind on their orders, with no prospect of catching up. It would be possible, however, to quickly revive the manufacture of the old-fashioned green bottle-glass, which can be made cheaply and without the use of the alkalis that limit the potential production of glass so seriously at the present time. We believe this has already been suggested to the Department of Commerce. The bottle-glass of fifty years or more ago was made chiefly from basaltic rock of suitable composition. In France a rock containing about 45% silica, 16 alumina, 20 ferrous oxide, 9 lime, and 3 to 5 soda, was extensively used for this purpose. Basalts were also employed in England and at a few of the older plants in the United States. Common sea-sand likewise has been found suitable, adding lime when the amount present from comminuted shells is insufficient. Such sands also contain important amounts of soda from the salt left in them by evaporation, which better adapts them to fusion for glass manufacture. If the tin shortage should prove to be real it is evident that means are at hand for supplying the lack with food containers of cheap glass. Small plants for the manufacture of jars from such material could be quickly established in many localities.

The Pyrite Problem

Sulphur is becoming daily a matter of deeper concern. It has been pointed out by Mr. Charles G. Wilson that the Union Sulphur Company in Louisiana, and the Freeport Sulphur Company in Texas cannot increase their output with sufficient rapidity to afford a supply of brimstone to take the place of the pyrite that would be required to produce sufficient sulphuric acid for fertilizer purposes within the time necessary to enable the manufacturers to meet the fertilizer needs for the fall crop of the present year. As a result of the existing situation, there has been abnormal activity in the investigation of sulphur deposits, which is justified in so far as such deposits can be made available for immediate exploitation. Deposits in Nevada and in Inyo county, California, are said to be promising, and large deposits of relatively low-grade but easily accessible sulphur are known to exist in western Texas, which are already being operated on a small scale. The methods of extraction from the superficial deposits in Texas so far have proved less efficient than might be desired, but it is largely a matter of technical detail to increase the degree of extraction. Under the present sharp accentuation of the demand, it would seem that these are as quickly available as any other deposits in the country. In the next place it should be pointed out that over a million tons, or 75%, of the total pyrite used in the United States for acid-making, comes from Spain, which supply has been entirely cut off. To keep up the production of acid it is necessary to install sulphur-burners in plants which are already equipped with pyrite-burners, which is a serious drawback. It would seem desirable that the case be met by some governmental provision whereby such highly pyritic ores and concentrates as contain considerable amounts of valuable metals in addition to copper, commonly known as complex ores, which would bear transportation to acid-plants, might be utilized to meet the emergency. Methods have already been worked out in sufficient detail to admit of the economic treatment of the cinder for the extraction of the larger part of the contained metals, and it would be appropriate that the Government should provide means that would permit of proper payment to shippers for the metalliferous content in these ores, even though the cinder should have to be stored for a period while preparations could be made for its further treatment reasonably near the point of roasting. The cooperation of the smelters and of ore-buyers in the West should be able to offer promptly to the sulphuric-acid plants a substitute for the Spanish pyrite. Some slight modification might have to be made in the pyrite-burners, but these are chiefly in the nature of means to prevent loss of heat by radiation, which present no insuperable difficulty.

Sampling Large Low-Grade Orebodies

Our readers will have noticed that in the interviews with Messrs. J. H. Mackenzie, D. C. Jackling, and H. C. Perkins we asked each of these engineers for their opinion concerning the practicability of sampling accurately such large low-grade orebodies as are being exploited in southeastern Alaska. The word 'erratic' might be added to the description of such orebodies, but this additional adjective is hardly necessary because the idea of irregularity is implicit: all large masses of gold ore are characterized by an irregular distribution of the precious metal, because so small a volume of gold is needed to change a ton of 'rock' into 'ore' that uniformity or homogeneity is out of the question. It will have been noted that not one of the experienced engineers whom we sounded on the subject expresseed any faith in the efficacy of the moil and hammer as a means for sampling a mass of several hundred thousand tons of $2 gold ore. Mr. Mackenzie advocated the milling of thousands of tons from different parts of the mine, and stated that the estimated average on which the Alaska Juneau enterprise is based was obtained by milling 50,000 tons broken across the orebody, supplemented by the information available from previous operations in the course of which 430,000 tons more had been milled. Even such large-scale sampling, he said, "is only an approximation, but it is as close as we can afford to go." Mr. Jackling could point with pride to the sampling, by means of churn-drills and also by mining, supplemented by mill-tests, on which the success of the Utah Copper was predicated; he also referred to the sampling of the Alaska Gastineau mine, which adjoins the Juneau, and explained how the results of sampling in this case had proved deceptive. The 375,000 tons milled by the previous owners of the property had been regarded as an average sample and the estimate based thereon had been confirmed by using a pilot-mill to crush large tonnages from different parts of the mine. Yet, when the big mill, having a capacity of 12,000 tons per day, started to work it was soon found that the yield per ton was $1.25 instead of $1.75 per ton, although both the estimates of cost and of recovery were more than substantiated. As Mr. Jackling says, it is easy to sample the disseminated copper deposits by drilling, and to do so both cheaply and accurately, because the orebodies lie flat and the copper is distributed with some degree of uniformity, but the large lodes of gold-bearing quartz standing at a high angle "cannot be tested," he says, "within the limits of reasonable expense for development, and with any satisfactory degree of accuracy." He also said that his experience at Juneau "indicates that sampling from development almost invariably shows results higher than they should be." Turning next to that sagacious veteran, Mr. H. C. Perkins, we find that he is much of the same mind. He did very little ordinary sampling before he advised the purchase of the Oriental Consolidated mines; he was furnished with trustworthy records of the yield from a number of small workings and from them he calculated the yield of gold per square foot of vein. This figure he used as his chief guide, having ascertained the cost of working. We have quoted the testimony of these three experienced engineers because we regard it as the equal of a whole text-book on the subject. The question is one that we would like to see discussed thoroughly by competent engineers. One of them, Mr. Howard D. Smith, criticized our comment on Mr. Mackenzie's remarks in the issue of March 3, and we would like others to do so also. In order to give further scope for an intelligent ventilation of the subject, we re-publish an excellent article on 'Sampling an Erratic Orebody,' from *The Mining Magazine* of September 15. This article, by Mr. L. A. Parsons, is likely to have escaped the notice of many American engineers, and it is one that we are glad to place on record in our own pages, so that it may form part of the evidence in the case. It was prompted by an earlier article by Mr. Morton Webber, whom we also invite to return to the attack. Mr. Parsons, it will be seen, supports Mr. Howard Smith's contention and both these younger (but far from inexperienced) men hold views opposed to those quoted in the earlier part of this discussion. Is a mill-test more reliable than a number of moil-samples? Is not a mill-test after all merely one large sample and does not the doubt always arise whether it is thoroughly representative? Is the crushing of a large tonnage from one part of the mine much more than a big grab-sample—the type of the fortuitous—and are a number of such big mill-tests any more than a series of similar grab-samples? We hope that our readers will ponder these questions and send us a reply. Broadly speaking, sampling is based on the doctrine of averages; the larger the number of samples the more trustworthy the final result, provided each sample is representative of the portion of the lode from which it came. The idea that a mill-test is more reliable than a thousand moil-samples pre-supposes that the mill-test is more fairly representative than the numerous smaller samples. Here two axioms may be interjected. The first is that the ore milled by the owner of a mine before he sells it is likely to be of more than average grade, and the better the miner in charge the more likely is his output to be of super-grade. For instance, the late John R. Mitchell, the former superintendent of the Alaska Perseverance, was a fine miner and just the man whom we should expect to select the best part of the lode for his stopes. All good mining is selective in a large way; it involves choosing those portions of the orebody that are likely to be profitable and then rejecting, as far as is economical, the waste inevitably broken with the ore. The second axiom is that any method of sampling, even on a big scale, by mining, but more particularly on a small scale, by moiling, yields a cleaner product than is obtained in the course of normal operations underground. Any sampling must be subjected to a discount in order to bring it to the basis of stoping in the usual way. Those who have sampled many mines know that the discrepancy between the early reports of competent engineers and the subsequent history of a mine does not come so often

from an incorrect estimate of the amount of metal produced as from a difference of ratio between tonnage and yield. The tonnage is greater and the yield per ton is less, as a rule, because the ore is not broken as cleanly as in sampling, and because a lowering of cost by efficient management leads progressively to the breaking of lower-grade ore. After all, the crux of the problem lies in the weighting of the data after they have been determined. One man takes a dozen samples, another a thousand, a third crushes 100,000 tons of ore, and in each case the evidence obtained is only crude material for intelligent ratiocination, beginning with correct inferences and ending in just conclusions. Any one of the three methods, plus a correct diagnosis of the ore occurrence, plus a dissection of the mine-records, plus a knowledge of human nature, plus technical experience, may suffice to furnish the information leading to a true estimate of the capabilities of a given mine, and any one of them by itself may prove fallacious. The subject is one of perennial interest, and the importance of it has received such emphasis lately that we hope to see it discussed thoroughly and carefully in the pages of this paper.

Our Restrictive Alcohol Laws

Alcohol has become an important problem in our preparations for effective warfare. In its industrial applications alcohol is one of the best friends that man possesses. The pages of a single issue of this paper would not suffice to enumerate the technical uses of this important substance. Considered with direct reference to the needs developed by the intense military activity of the hour, among which may be mentioned, aside from explosives, the demand for the manufacture of medicinal tinctures which will be larger than ever before, as well as the requirements for the manufacture of enormous quantities of ether, in which alcohol is an absolute necessity, it becomes apparent that early legislative action is desirable. It has been pointed out by Mr. Richard H. Edmonds that a war prohibition-measure would save enough grain to provide a loaf of bread per diem for 11,000,000 men. This is one way of looking at the problem, and a useful way. It indicates furthermore that the use of alcohol in beverages reduces the amount available for necessary purposes in manufactures, including the provision of medical comforts. But this is not all; the kitchen waste, part of which is unavoidable, constitutes to an important extent, an available source of alcohol, but we are not organized for utilizing this material. The remedy lies with Congress. Some years ago a number of patriotic citizens in this country undertook a denatured-alcohol propaganda. An association was formed in New York, and thousands of men throughout the country contributed to the support of the organization, the purpose of which was to educate the people to the possibilities of denatured-alcohol to be used partly as a substitute for pure alcohol in a large number of industries where the adulterant produces no detrimental effect, and chiefly as a source of cheap heat, light, and power, in small plants. Had such a wise measure as the denatured alcohol association proposed been passed by Congress, the development of the country would have been promoted in various ways, and agriculture itself would have experienced a stimulus which would have tended to cheapen the cost of food supplies as well, since the rotation of crops would have been necessary, and the net result would have been to bring larger areas under cultivation. When the agitation had reached a point where it was inevitable that some action would be taken, the Standard Oil Company, realizing that this competition would lessen its ability to control the gasoline-market, succeeded in having a bill introduced as a substitute for the one that was intended to provide cheap alcohol for the public, and this substitute-bill placed such restrictions upon the manufacture of denatured alcohol as to prevent production under conditions that would admit of small local associations entering into the business. It is time that Congress should reconsider this question, and put on the statute-books a denatured-alcohol act that will permit of manufacturing this commodity under economical conditions. Dr. Allen Rogers has recently insisted that, "instead of making alcohol for drinks, we should make it for the manufacture of explosives, for ether, for medicinal purposes, for fuel, for dyes, shellacs, and for every use to which it can be put in this supreme moment when all things must be turned to the Nation's greatest good." It is certainly suicidal to permit the sale of alcohol as a beverage at a time when it is urgently needed for the safety of the Nation in war, and it will be hard for Congress to excuse itself for having failed to utilize the waste materials of the country in the manufacture of denatured alcohol, when all the world knows that the present laws are restrictive in their operation and intent, and were so drawn for the benefit of a few wealthy monopolists. At the same time synthetic alcohol has been made a possibility by a process already established on a working basis in Switzerland. This involves first of all the manufacture of calcium carbide in the electric furnace. Acetylene is generated from the carbide in the ordinary way by water, and then, under the influence of a catalyzer, hydrogen is added to the molecule, producing ethylene. That in turn is dissolved in sulphuric acid, and saponified by boiling with water, when it yields alcohol with regeneration of sulphuric acid. Thus it is possible to utilize the waste water-power of the Pacific Coast and of the South Atlantic States in the manufacture of calcium carbide to be directed to the production of alcohol, but such enterprises are hampered by the enormous tax of $2 per gallon on spirits. The excise tax fails to restrict the use of alcohol in beverages, while it embarrasses its legitimate industrial application. Prevention of the improper consumption of alcohol can be effected by suitable prohibition measures, coupled with provisions that would limit its manufacture, sale, and technical use, under the control of persons required to give bond in appropriate sums. Development and control of the alcohol industry should be constituted a public trust, but should be no more complicated by obstructionist legislation than the conduct of banking, which also necessitates reliance upon an army of trustworthy men.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

The Potter Process at Broken Hill, Australia

The Editor:

Sir—In response to an invitation in the Mining and Scientific Press, of March 17, I wish to direct attention to two statements in the discussion of the Potter process which are not strictly in accordance with results obtained by extensive investigation and experiment under my superintendence at the works of the Zinc Corporation at Broken Hill, Australia, now nearly a dozen years ago. The "derivatives capable of replacing oil" in the Broken Hill tailings are not "shrubs and other organic substances" but the common minerals fluorspar and quartz which react with the hot sulphuric acid, to form gelatinous silica, a substance possessing certain physical properties, including that of selective adhesion to lustrous bodies, similar to those of thick oils or grease. This is a matter which, although extremely interesting, has not yet, so far as I am aware, been recorded in the literature of flotation work. The only published reference to it seems to be that contained in a short letter which I wrote in 1910 for the London *Mining Magazine*. Certain investigators, as for example, O. C. Ralston and Glenn L. Allen (M. & S. P., Jan. 1, 1916) have, however, observed, when experimenting with the Potter process on a laboratory scale, that "a great deal of mineral is often partly lifted but never reaches the surface. Consequently extractions are low." This would indicate that the materials then under examination were lacking in these very "derivatives capable of replacing oil" otherwise the mineral would reach the surface and tend to persistently stay there. By blending the component minerals in rotation so as to gradually produce an artificial mixture with similar composition to that of the Broken Hill material, and noting the results obtained on immersing in hot sulphuric acid, A. J. F. De Bavay has shown that the absence of fluorspar would render the Potter process impracticable. The mineral would tend to rise to the surface, but would not remain there a sufficient length of time to permit of its transference to a suitable receptacle for collection as a valuable product. While on this subject, I may also correct a statement of C. T. Durell (M. & S. P., Feb. 19, 1916) who, in comparing the value of representative concentrates produced at the various Broken Hill flotation plants, reported that the difference in the grade is obtained "by reason of mechanical refinements and not the difference in process." My own researches have proved that the particles of sulphide recovered by the Potter process and also by the Delprat modification, are smeared with colloidal silica to the extent of about 5% of the actual weight of the concentrate produced, and that the tenacity of the adhesion is so great that separation is not possible in the wet state by mechanical means. If heat, however, be applied to the concentrate, its greasy shining appearance quickly disappears, the silica crystallizes, and its separation is easily effected on Wilfley tables or with magnetic machines.

The second inaccuracy is the inference that the all-important flotation agents in the process are the bubbles of carbonic acid which "by attaching themselves to particles of mineral buoy them to the surface." In a series of tests which I conducted in 1906 on a gradually increasing scale from that of 100 grammes in the laboratory to that of 1000 tons in the full-size plant, I was able to prove that the influence of carbonic acid is chiefly that of an auxiliary flotative agent, operating by becoming mechanically entangled in the clotted masses of the silica-smeared sulphide particles, and that, in reality, the fundamental buoying factor in the Potter, as in all other flotation processes, is air. The Broken Hill tailing, to which the Potter was the first flotation process applied, is composed of the sulphides zinc blende, argentite, and galena, and of rhodonite, quartz, calcite, and fluorspar, as gangue. The pioneer plant was erected on the Block 14 mine for the purpose of recovering the valuable sulphides of zinc and silver from an accumulation of tailing derived from ore that had previously been finely crushed and treated on Wilfley tables for the extraction of lead. The results were highly profitable, another contributing factor to success being that the dumps selected for treatment contained material that had been carefully sized and washed free from slime and proved to be among the very richest in silver-content in the whole Broken Hill district. Usually when a suitable system of metallurgical treatment for an ore is being sought, consideration is given primarily to its chemical nature, but, with flotation work, most other factors possess a highly important bearing which the metallurgist, trained in the school of chemical reasoning, is likely to overlook. In this connection it is worthy of note that Charles V. Potter, the discoverer of the process to which he gave his name, was a pharmaceutical chemist, who, judging from correspondence that I personally had with him, knew little of general metallurgy and absolutely nothing of the principles governing the success of his own invention, and that A. J. F. De Bavay, Australia's brilliant investigator, was, by profession, originally a bacteriologist, trained at the Pasteur Institute in Paris. Incidentally, too, I may mention that in conducting the original work for the Zinc Corporation

in 1905-6, I found frequently that my own past experience in other branches of metallurgy, principally in cyanidation, was to a certain extent somewhat of a handicap. This was particularly the case when I installed a labor-saving device in the form of a conveyor-belt for receiving the zinc-bearing tailing from the lead-extraction mill, draining it of its associated water, and delivering it as feed into the hot sulphuric acid of the Potter appliances, all in one operation, thereby replacing the costly system then in vogue of trucking the wet tailing to a dump and, at a later date, shoveling it into cars and raising it to the receiving level of the flotation plant. From an economic point of view this alteration was a splendid success, but the metallurgical result was a worrying disappointment. Carbonic acid was liberated in abundance, but the sulphide particles refused to rise, and the extraction fell almost to zero. The solution had gone 'flat' and the froth, which previously had been so characteristic of the successful working of the process, had disappeared. So bad was the situation that flotation had to be suspended and a campaign of investigation started, a state of affairs not agreeable to the Zinc Corporation directors. Chemical analysis failed to indicate the cause of the trouble, and consequently the material as crushed was allowed to accumulate on the dump for later treatment. It was then noticed in laboratory tests that the extraction improved with the length of time that the material was allowed to remain on the dump. A resumption of operations on this self-same, partly dried material gave unexpectedly favorable results, the actual extraction being 92.5% of the zinc-content, yielding a concentrate assaying 46% zinc, this being a grade higher by 4 units than the best previous record. It must be remembered that this was in July 1906 when chemistry was the sole science of reference generally employed to explain metallurgical phenomena, and when practically nothing was known of the physical principles involved in flotation work. At this point, it dawned on me that aeration was essential, and further experiment confirmed that view. The culminating point was reached when I rigged up some make-shift appliances to test my conclusions on a 1000-ton scale.

Large galvanized iron tanks were rapidly erected, fitted with filter-bottoms as for cyanide work, and, as a temporary expedient, were filled in turn with the pulp from the mill by means of a hose. Drainage through the filter-bottoms was assisted by a vacuum created by a steam injector. When sufficiently drained, and consequently aerated, the interstitial spaces between the tailing-particles being filled with air instead of water as formerly, the content of each tank was discharged by shovel upon a conveyor-belt and fed direct to the Potter appliances. The results obtained caused excitement both locally and among the stockholders abroad, for not only was the extraction considerably higher than had been expected, but the grade of concentrate produced was of a quality then believed to be obtainable only by the use of oil.

To further demonstrate the possibilities of the Potter process on suitable material I had a quantity of concentrate dried and treated on a magnetic separator and obtained a finished product assaying 51% zinc which, because of the associated iron in the mineral, is as high a grade as is possible to obtain. The waste products from the magnetic machine were white crystalline silica and galena. My researches with the Potter process showed that its fundamental buoying agent is air, that the 'collector' is colloidal silica which, in the gentle current of hot sulphuric acid, collects the air-enveloped sulphide-particles into clots, and that carbonic acid bubbles, by becoming entangled in these clots, help to bring them to the surface as a scum or froth.

W. E. Simpson.

Cobalt, Ontario, May 7.

Mine Samples as Baggage

The Editor:

Sir—Your issue of March 31 contains a letter from Horace Stanton on a subject which claimed my interest some time ago. I had a similar experience with a baggage-man at Seattle in 1913 and wrote to W. H. Merriman the Division Freight and Passenger Agent here in Butte as follows: "On my return to this country from a mine examination in British Columbia, I had with me a large leather sack, commonly known as a 'War Bag.' This sack is of a type in general use by mining engineers, constructed of sole-leather or some equally heavy leather, with handles at each end, and bound by a heavy trunk-strap. Up until this trip I have never had the question raised by the Northern Pacific Railway as to whether the sack was checkable or not. These sacks are used to carry digging-clothes, such things as are necessary to a mine examination, and the samples taken at each mine visited. It is necessary in a mining engineer's work that these samples should accompany him and reach his destination at the same time he himself does. This can be accomplished, usually, only by checking the sack as baggage. At your Seattle baggage-room, the baggage-master refused to check this bag, on the ground that the samples were not personal effects, and therefore were uncheckable. I was forced to send the bag by express, and I enclose the receipt for the same. It seems to me that these samples should be regarded as personal effects, for the simple reason that they are not a commercial commodity, and are of no market value. They are of no use to anyone, except the engineer who has taken them. They are a part of his outfit, and as such, are as necessary to the transaction of his business as the samples carried by a commercial traveler. In a sense they are representative of the value of what he has to offer to a market, in the same way that a traveler's samples are. Under the circumstances it seems to me that this bag should have been checked, and that I am entitled to a refund in the amount of the express, $11.85, paid to the Northern Express Company."

Mr. Merriman took it up with the head-office at St. Paul with the result that they took the same view re-

garding my samples as that expressed in my letter, and a proper refund was made. Later I wrote to Bradley Stoughton, hoping that the Institute could take some action which would require all the railroads to adopt the view of the Northern Pacific. Mr. Stoughton's reply is enclosed, but, so far as I know, no further steps were taken in the matter. Since 1913 I have had no trouble with the railroads in the North-west except the Grand Trunk-Pacific. In the South-west I find that the Santa Fe and the Arizona Eastern refuse to check such baggage.

FRED T. GREENE.

Butte, Montana, April 11.

(Copy of letter to Fred T. Greene.)

September 22, 1913.

Dear Mr. Greene:

I am very glad indeed to receive your letter of September 14, concerning the action of the railroads in refusing to carry bags containing samples for assay. It is just this sort of thing that we like to be informed of, as it seems to be an opportunity for the Institute to do good by co-operation on all sides. I only returned this morning from nearly two months absence at the Butte meeting, visiting the local sections, so I can only acknowledge your letter, but will write you more fully later. Again assuring you of our pleasure in having these matters brought to our attention, and with personal good wishes,

Faithfully yours,

BRADLEY STOUGHTON,
Secretary.

A Stalagmite of Native Copper

The Editor:

Sir—In the Butternut mine near Mayer, Arizona, was recently found a stalagmite of copper, capping the nut of a hanging rod in the shaft. The specimen is now in the possession of Maj. A. J. Pickerell, at Prescott. It is about 3 in. high by 1 in. diameter and weighs about one pound. The copper is crystallized throughout, and clusters of fairly well developed crystals branch laterally from the main column. From all I can learn the copper must have formed during the last 4 to 7 years. This occurrence strikes me as remarkable, not only on account of the rapidity of the precipitation and the beauty of the specimen, but also because apparently chemical reactions must have taken place that usually are not considered in the genesis of copper deposits, namely, the direct precipitation of native copper from copper sulphate solutions here with native copper acting as a catalytic. While the beginning of the precipitation is apparently due to the normal displacement of copper by iron in the sulphate solution, with simultaneous deposition of native copper, the further growth of the stalagmite cannot be explained in the same way, and I believe it possible that other reducing agents might accomplish the same process. There are, for instance, the remarkable seams of native copper and cuprite, the cuprite in this case being a result of the direct oxidation from the native state, occurring in certain shales in Morenci. Waldemar Lindgren remarks on this peculiar occurrence, and explains it as a replacement of chalcocite, if I remember correctly. These seams are narrow, and show radiation, and are structurally almost identical to chalcanthite seams found in the same locality. I was inclined to consider them as pseudomorphs of native copper and cuprite after chalcanthite, and I believe now, more than ever, that this explanation might be correct.

W. TOVOTE.

Bisbee, Arizona, May 11.

Nitrogen in Metal Mines

The Editor:

Sir—Relative to the articles that have been appearing on this subject, an interesting occurrence is noted in 'A List of Canadian Mineral Occurrences,' by Robt. A. A. Johnston, of a bore-hole put down on Pender island, Strait of Georgia, B. C., from which natural gas composed of 94% nitrogen and 6% carbonic acid with a trace of oxygen was issuing at the rate of 100 cubic feet per minute. No account is given of the formation; perhaps Mr. Johnston can throw some light on this point.

If other conditions were favorable, such a gas would be useful for the manufacture of synthetic ammonia.

F. H. MASON.

San Diego, Cal., April 30.

ELECTRIC-STEEL production in the United States has progressed so rapidly, according to a statement by John A. Mathews in the Bulletin of the American Electrochemical Society, that the existing plants have a capacity eight times greater than the crucible-steel output, and one-eighth more than that of bessemer steel. The total production is 1,250,000 gross tons of ingots and castings, coming from over 100 plants in operation. Electric steel is chemically purer than any other, and sulphur especially is easily removed. Segregation of phosphorus or sulphur is not to be feared, and hence the percentage of 'cropping' is reduced, thus effecting economy. These steels, moreover, are freer from slag and non-metallic inclusions than bessemer and open-hearth steel. The use of the electric furnace admits of recovering good steel from low-grade scrap, and of producing a maximum yield of sound metal from a minimum of raw material. The chief drawback to the development of the industry is the policy of the Government, which prevents the economic utilization of water-power. In Norway hydroelectric power can be had for $6 to $12 per horse-power-year. In this country the average is above $20.

TOTAL GOLD in general stock in the United States on May 1 was $3,088,904,808. The U. S. Treasury held as an asset of the Government $203,868,088 and the gold in circulation was estimated at $667,338,062. An outward movement of gold is also noted, a shipment of $3,250,000 from San Francisco to Japan having just been made.

Sampling an Erratic Orebody

By L. A. PARSONS

*In your issue of February last there appeared an interesting article by Mr. Morton Webber on 'Latent Errors in Mine-Sampling.' In this article Mr. Webber classifies the type of erratic ore occurrence, in which the valuable mineral occurs in bunches, under the general heading 'Mines where Sampling is no Use,' and recommends the mill-test as the only reliable method of valuing such mines. To quote: "The only method of reliable valuation in a deposit of this type would be based on authentic record of past yield, in combination with competently selected representative shipments of the remaining ore."

With this I cannot altogether agree. Authentic record of past yield is of the utmost value, but I believe that this is much better studied in combination with proper sampling than with mill tests. I do not refer to those tests made to determine metallurgical treatment, or to those made over an extended period of time to confirm sampling results, and which amount to operating the mine under option, but to the mill-tests designed to take the place of sampling because considered more reliable—'representative shipments.' These practically amount to large samples, and my contention is that they are no more justified in an erratic mine than in a uniform one; rather less so, if anything, for the chances of error are greater, and the safety resulting from averaging a large number of samples is needed. Before discussing this further, I shall describe briefly the methods used and results obtained at one mine of this type that I had the privilege of sampling and studying in great detail for a period of two years. This mine forms an excellent illustration of this type of deposit, and of some of the principles that affect the accuracy of the results when sampling by the ordinary hammer-and-moil method.

The formation at the mine in question consisted of highly metamorphosed sediments and igneous rocks, carrying irregularly scattered lenses of gold-bearing quartz ranging from almost miscroscopic size to several feet in thickness. These schists without quartz would assay from nil to about 3 dwt., averaging less than 1 dwt., and the quartz from nil to several hundred pennyweights. Frequently the gold was in coarse flakes, making most brilliant showings. The quartz stringers, in combination with the richer portion of the schists, formed erratic ore-zones separated by comparatively large zones of waste, and showed no consistency, taken either singly or in groups of any size. There was no habit or condition that could be discovered affecting the sudden changes from spectacular ore to practically barren waste. Mr. Webber mentions levels 30 ft. apart giving erratic results. I remember one cross-cut, sampled by a continuous channel along each wall, of which, over a distance of 200 ft., one wall averaged one-third of the other. These walls were perhaps 5 ft. apart. The troublesome nature of the ore was evidenced wherever samples were used; in the assay-office, duplicates would not check at all unless ground to 200-mesh; in the mill, samples of battery pulp over a month would not check amalgam plus cyanide headings. The amount of underground development was hardly greater than would have been necessary to stope a uniform deposit of the same size, and very different from the network that Mr. Webber states to be necessary for deposits of this type. Levels about 80 ft. apart, and drifts and cross-cuts about 150 ft. and 75 ft., with of course local modifications for all of these, is not a large development proportion. In fact, per ton of ore blocked, it is small. According to my opinion these conditions formed as extreme an example of Mr. Webber's classification and as difficult a problem as one would be likely to run across. And yet this mine was sampled and ore blocked out, and is being sampled today. The results are of the utmost value, both to the men financing the property and to the management planning exploration and development work. It *had* to be sampled. There was no other method of working it intelligently.

The method of sampling did not differ in any essential from that in general use by a large number of engineers, so a brief description of this should suffice to make it clear. As neither the quartz stringers nor the ore zones had any definite trend, samples could have been taken in almost any direction. For ease in sampling all channels were cut horizontally about breast high along the sides of the drifts and cross-cuts. A distinction was made between drifts and cross-cuts according to their relations to the stopes, but structurally they were the same. Both sides were sampled, as so little was known about the deposit at first that all the information obtainable was needed. These channels were the usual kind cut with a hammer and moil, and yielded about 1.5 lb. per ft. The rock surface was first cleaned with a scrubbing-brush, and the channel, about 3½ in. wide, outlined with chalk. The samples were caught in an ordinary iron meat-pan about 12 by 18 by 2 in. This was more easily cleaned than a candle-box or canvas, and made possible a more detailed examination of the sample as it was cut. In the low-grade or barren schist, samples were taken up to 60 in. long, but in ground which was apparently rich no sample was taken more than 30 in. long. This was in uniform rock. With every change in the character of the ground the sample was bagged and a new one started. In small quartz stringers this would frequently give samples not over 3 in. long. In such cases the size of the channel was always increased to make

*Reproduced from *The Mining Magazine* of September 1915.

the total weight of sample not less than 2 lb. Quartz containing the coarsest gold was not avoided in any way, but everything within the outline taken as mechanically as possible. Any adjustment necessary was made in the office afterward.

The question of high assays was of course always coming up. The first step in their treatment was re-sampling. All places yielding erratic assays were re-sampled in the bottom of the original channel. The decision as to whether an assay was erratic or not did not depend so much upon its tenor as upon that of its neighbors. An assay of 10 dwt. in one place might mean a re-sample and in another one of 50 dwt. be let go. The two or three assays of the same place thus obtained were averaged and the resultant tenor entered in the records with no reduction. At the times of calculating the ore-reserves, when studying the relation of each sample to all the others, it occasionally seemed advisable to cut down an assay to a tenor more consistent with the apparent structural importance of the rich spot yielding the sample. In addition to this, an arbitrary high figure of 500 dwt. was adopted, to which all assays above that figure were reduced. There were so few assays higher than 500 dwt. that it was thought they would affect the average out of proportion to the probabilities of their being duplicated in the interior of the blocks. These two causes combined affected a negligible proportion of the assays—probably less than one-tenth of 1%—and it is merely to show the methods of work that they are mentioned here.

In connection with the re-sampling an interesting fact was observed: the majority of times the re-sample gave a lower result than the original. I think the reason for this is clear. The occurrences of rich specimen ore were on the average so small that it was probable a large proportion of such an occurrence would be cut away by the offending sample. Similarly, I have no doubt that re-samples of the promising looking ground which had returned low assays would have given on the average higher results than the original. The averaging of the two assays thus introduced a slight factor of safety.

It will be evident from what I have said regarding the size of the rich zones that any attempt to mine them separately would have been absurd. The only feasible project was to take all within the mineralized zone. Therefore, in valuing ore blocked by the sampling results, the ground was considered as a low-grade mass, and no attempt was made to segregate tonnages for the small rich zones. This resulted in a method much the same as would have been used for a more uniform deposit. After the few adjustments of the high assays had been made as described above, the ground was divided into areas as indicated by the horizontal workings, and each area valued by dividing the total inch-pennyweights of the periphery, high and low alike, by the total sample-length in inches. The blocks between levels were valued by weighting the tenor at each level by the area blocked. Raises in general were used merely to prove continuity of ore, although occasionally their tenor was averaged with that of the levels. The final result was adjusted according to knowledge of the mine. Bore-hole results were of great assistance in this, although used entirely for information as to continuity and not for obtaining tenor; and as mining progressed the samples from the development were supplemented by moil-samples from the stopes. The latter were averaged with the development samples when practicable.

The results of this method were highly gratifying. For a period of two years, the tenor of the total ore mined as indicated by moil-samples, when compared to amalgam plus cyanide headings for a quarter of a million tons milled, indicated a sampling factor of 112%. I regret that I am not at liberty to give figures in greater detail, but I think these will illustrate my point. It may be contended that these results indicate nothing, because the work was done by the staff, who brought their intimate knowledge of the mine to the final interpretation of the results. This was undoubtedly a factor, but it was a factor dependent upon experience and not upon any lessening of the difficulty of the work. Any independent engineer with sufficient experience could have arrived at the same results. In fact, in the early history of the mine, an examination was made by an independent engineer who predicted almost exactly what would occur.

The above example illustrates certain principles that I think can be applied in a greater or less degree when sampling any erratic deposit. Although it is an axiom in mine valuation that every mine must be judged on its merits, according to the experience of the examining engineer, and no hard and fast rules can be laid down, still I think these principles form a good foundation for working, and are certainly of more general application than considering sampling utterly unreliable and not using it for the data that it can give. I shall try to state these principles as I see them, omitting the actual manipulation of the sample, precautions against the increased danger of salting oneself, and details of that nature as being sufficiently taken up in the short description of actual practice above.

How to average high assays is apparently the question that bothers the majority of men most. There is a vast difference between the occasional high assay in ore of essentially uniform tenor, and the condition where the recurrence of very high erratic assays makes up almost the entire value of the ore. In the latter case I believe the result will in general be nearer the truth if high assays are reduced very sparingly, and then only for extremely good reason; assuming, of course, that there is sufficient development work to allow the law of averages to work. A high assay represents the tenor at a spot sampled. Whether that ore extends to the next development working or not is immaterial; the assumption is that it will be duplicated by other small patches within the blocks. Erratic and variable though the rich intersections may be over short distances or in workings close together, when taken over sufficient length of workings the average will represent, within the limits of error to be decided by the engineer, what the entire mass of

ore blocked out will yield. The theory is exactly the same as that which governs uniform deposits, but engineers seem to fear to apply it to the type under discussion. The high assays in the mine I have described were not sufficiently frequent to consider them the usual thing—in fact quite distressingly infrequent at times—and yet an attempt to cut them down by any of the well vouched for methods would have resulted in indicating on paper merely a large mass of waste. I am not at all sure, from the mine's subsequent history, that even the slightest reductions I described were justified. When sampling such a deposit, samples should be cut impartially through rich and poor alike, the mine studied structurally, and when the assays are in, all the information correlated before making up the averages. Then if for any reason some assays should be reduced, well and good; but an assay should not be reduced without knowing why it is done, merely on account of some vague idea that it is good practice and playing safe.

Two much discussed methods for increasing the accuracy of the results on such a deposit are decreasing the sampling interval and cutting the ore into small blocks. I do not believe that either of these is exactly the remedy. What is desired in sampling is to obtain sections of the orebody that are representative of its tenor as a whole. It is obvious that if the development openings are not thus representative, no amount of close sampling will increase the accuracy of the final result; it will merely increase the accuracy of the tenor assigned to those development workings. Therefore the sampling interval need only be small enough to give the tenor of the workings to a degree of accuracy consistent with their representation of the mine as a whole. Decreasing the intervals below this point adds nothing. As for cutting the ore into small blocks, this will increase the accuracy of the estimate for each block, and therefore for the entire developed portion of the mine; but is that exactly what we are after? In most cases the maximum amount of development that can be done is more or less a fixed quantity; compressor capacity, shaft or tunnel capacity, and cost limitations all contribute to this. The development that is used to cut already developed ore into smaller blocks is not exploring the mine for extension; and it is the results of this exploration that more than compensate the engineer for the lessened accuracy of each single block. To put it differently: the smaller the blocks, the more nearly accurate is the tenor assigned to the ore thus outlined; but if we grant that this ore is only a small portion of the whole, then the larger the blocks, that is, the more the development is spread out, the more representative of the whole this development will be. There must be enough samples for the law of averages to work, for the high assays to represent what will, on the average, be found in the interiors of the blocks. As shown above, obtaining this number by decreasing the sampling interval avails nothing; the samples must be from representative development. Therefore the accuracy of the result when sampling an erratic mine depends most upon the total amount of development in the ore, not the amount per ton, and the blocks need not be smaller than would be required for mining.

The question of valuing by sampling a mine where the values are like 'plums in a pudding,' as it has been so aptly phrased, compared to the mine where values are evenly distributed, is not one of impossibility, but of relative accuracy. The error will be larger than with a uniform deposit, but as long as the probable limits of error are known, the results will often be as useful as if they were more accurate. Within these limits of error, by working according to the principles outlined above, ore can be blocked out as in the uniform deposit. However bad conditions may be, they will affect the mill test more than they will sampling. Certainly I know of no method of making a mill test on the mine I have described that would have yielded information at all comparable for accuracy with that obtained by sampling. Two years' actual production gave no indication of what the tenor of the mine as a whole would be; yet the current sampling indicated it after the mill had been running six months. It was over two years after a certain tenor had been predicted by sampling before the mill results began to conform to that tenor. The reason for this is perfectly obvious: the stoping was not done from representative places. *Representative*—that is the crucial point. Unless a man is a clairvoyant, there is no method of obtaining representative shipments. And if he could select the proper places, a few holes one way or the other by the machine men would entirely alter the tenor of the test. It comes right down to the old question of a few very large samples versus an enormous number of small ones—a question that has been many times discussed. Obviously, I am an advocate of small samples.

It seems to me that often such stress is laid upon great precision in mine sampling and valuation that sight is lost of larger issues that are more vital. Some of these have been outlined above, such as spending time and money on work whose sole object is to gain greater precision in the tenor that is assigned to the ore, rather than spending it on exploratory work that would give much needed information as to the future of the mine. And certainly this striving for great precision has no more serious consequences than when it prevents an engineer from giving any opinion as to the value of a mine, because its character is such that the results cannot be accurate within the limits of error he has assigned himself. The erratic mine is the most difficult problem the examining engineer has to face, but that does not alter the fact that it must, upon occasion, be faced. To reduce high assays sweepingly for no reason except custom, or to refuse to place any reliance upon sampling through an excess of conservatism, is to side-step the issue. The best opinion obtainable on the value of this type of mine is that honestly given by an experienced engineer without undue conservatism or optimism, after an adequate study of the mine structurally, a thorough sampling, and an analysis and correlation of the assay returns with the structural data obtained, and past yield if obtainable. To this opinion an engineer's clients are entitled.

VEREENIGING POWER-STATION ON THE VAAL RIVER

Mining Problems on the Rand

By H. FOSTER BAIN

A complete discussion of the various problems that confront the mining engineers and metallurgists of the Rand is far beyond my scope. The title of this article is intended rather to call attention to the fact that there are still unsolved problems on the Rand and that there are points in current practice regarding which a visitor may have doubts. It will do no harm to ventilate these questions. If the criticism be justified it may lead the able engineers and managers on the Rand to search for and perhaps to find a better way; if it can be shown to be unjustified it may still serve the useful purpose of calling out from some of our friends a clear statement of the reasons underlying the course adopted, and so result in contributions to technical literature of permanent value.

It is well at the beginning to point out the peculiar conditions under which a Rand mine-manager works. He is responsible for a large unit of production; he works under trying conditions as to labor, in a region where the cost of supplies must always be high and the necessity for carrying large stocks imperative. He has to his advantage orebodies of which the regularity, even allowing for some over-emphasis in the past, is truly remarkable in gold mining, though not equal to that obtaining in other deposits. He has long had, also, such an abundance of capital as is unusual in gold mining. Provided that a profit could be shown as a result of increasing the scale of operations, building heavier machinery, or sinking deeper and more expensive shafts, the engineer on the Rand has needed unusually but to ask in order to receive. To managers struggling elsewhere with erratic orebodies owned by companies devoted to making the mine "pay its own way from the grass-roots down," the conditions on the Rand have appeared a little short of ideal. A visit, however, brings out the fact that the men who work there have their troubles as much as do their fellows on the Mother Lode or the Golden Mile.

Aside from the complications of labor regulations, taxes, and railway-rates growing out of the politics of a country in which there are divers races to consider, and few established industries, the greatest difficulties are connected with the very factor that might be assumed to be most favorable, namely, abundance of capital. I shall give later some statement as to what the amount of capital is, but, as regards the mine-manager, the essential factor is that the money comes from the public. He works not for owners but for trustees; the big Rand houses are only in small part actual owners of what they control and manage. While the consulting engineer of any of the big groups has, within his province, a remarkable freedom of action, and there are few engineers anywhere who occupy positions of greater responsibility and dignity than the leading men at Johannesburg, in other directions their freedom of action is definitely limited. The general policy of each house is determined by the financial managers and not by the engineers, and in formulating it the managers have always to regard the source of the capital, namely, the public market for shares. However excellent from an engineering point of view a project may be, it cannot be considered if it will unfavorably affect the market in anything more than a temporary manner. Such a situation has both advantages and disadvantages. Some, highly regardful of their position as trustees for others, will tend to over-conservatism in management. Others, relying on the market to make good any personal loss incurred, will take chances that they could not face without this recourse. On the whole, their responsibilities have been taken seriously by the Rand houses and the result has been a conservatism in management that is often considered excessive by outsiders. Coupled with this has been a cheerful optimism when it came to floating companies or effecting consolidations. To one on the side-lines it often seems that the

financiers concerned with the Rand are not averse to taking chances in the field that they consider their own, but are decidedly averse to their technical advisers adopting any such daring attitude.

It is right and proper that the technical methods adopted in mine-management should take cognizance of the source of the funds employed. If, however, in practice this means the toleration of expensive methods where from the point of view of technology alone cheaper ones are applicable, it is also proper that the extra cost should be duly set out so that there may be a clear understanding. The expenditure may be entirely proper judged as insurance, such as the interest charge on developed ore-reserves, or it may not. Whether it be a wise policy to incur the extra cost is a fit subject for consideration as a matter of policy, but it is not proper to lay down artificial conditions and then hold engineers responsible for costs; that this is done to some extent would be my criticism of present Rand mining practice.

The extent and scale of mining on the Rand is already familiar to my readers. It will suffice to recall here a few figures taken from the yearly report of the Transvaal Chamber of Mines. In 1915, 53 mines produced 31,331,316 tons, which after sorting out 9.62%, yielded 28,314,579 tons to be milled. The reduction works included 9396 stamps and 307 tube-mills, operated for an average of 316.69 days, with a duty per stamp equivalent to 9.53 tons. The total gold extracted was 8,722,919 fine ounces, valued at £37,264,992 equivalent to 26s.3d. per ton milled. The working cost averaged 17s.5d. per ton, the working profit 8s.5d., and dividends 4s.10d. per ton.* The contributions to the world's gold output now made annually by the Transvaal, including the outside districts, amount to about 40% and the total yield of the Rand to the end of 1915 is estimated at 106,941,089 fine ounces. The average number of white employees on the Rand in 1915 was 22,017, and of natives, 211,096. The number of rock-drills in use was 5675 and the amount paid for salaries and wages £13,501,291. The total value of stores purchased for consumption in that year was £10,889,115.

Originally small mines were opened along the outcrop. Later the deep-levels and still later the 'deep deeps' were opened and the period of consolidation began. Out of it has come the system of group-control with head-offices at Johannesburg, where each group maintains a general technical staff and responsible manager at each mine.

The consolidation and growth of the group system of control has proceeded to such an extent that virtually all the Rand mines are affiliated with some one of nine groups. There is much joint ownership and many of the properties have been financed by co-operation of several groups, as in the case of Daggafontein, which is now being re-opened by the Consolidated Mines Selection Company, with the assistance of the Central Mining & Investment Corporation.

The Rand Mines consolidation, while independent, is closely affiliated with the Central Mining, both being 'Corner House'† companies and the outgrowth of the activities of Wernher, Beit & Co., which firm, as will be remembered, was represented on the Rand by the house of H. Eckstein. The Gold Fields organization grew out of the activities of Cecil Rhodes, and the Consolidated Investment Co. out of those of Barnato Bros. The General Mining & Finance Corporation is known as the Albu group. The Brakpan and Springs mines represent the growing Consolidated Mines Selection interest.

A general view of the business of mining on the Rand may be obtained from the following figures, taken from the report of the Transvaal Department of Mines and Industries for 1913, the last complete year before the War. Up to that time 103 mines had reached various stages of development or operation. Of these, 40 had become dividend-payers. The following figures show the main facts as to capital:

	Dividend-paying mines	Total of all companies
Net issued shares	£36,219,995	£59,797,942
Outstanding debentures	5,744,940	8,775,238
Unamortized premium on shares	4,960,142	8,176,744

The total dividends for the year amounted to £8,205,-201, equivalent to 10% for the whole outstanding and unamortized capital, or 17% if only the dividend-paying mines be taken into account. This calculation neglects the value of plant, surplus, stores, and other items; it is concerned only with dividends and capital. It has, of course, nothing to do with what may have been paid for shares, only taking into account what the companies received, and assumes that property paid for in shares was of the real value represented by them. Taking all these facts into account the showing is undoubtedly a good one.

Another tabulation of some interest is that giving the gross yield of the Rand and the percentage paid out as dividends:

Year	Output £	Dividends, %
1902	7,179,074	29
1905	19,991,658	24
1908	28,810,393	30
1911	33,543,479	24
1914	34,124,434	24
1915	37,264,992	20

This again is a record much better than might have been anticipated by one familiar only with market-news, which deals rather with share-values than the actual results of mining.

Turning now to present-day problems in Rand mining, the most portentous is undoubtedly how to reduce the working expense per ton so as to save the decreasing margin between yield and profit. The necessity for some

*Owing to the fluctuation in exchange it is not possible to give the American equivalents accurately; as an approximation the pound may be taken at $4.86 and the shilling at 24 cents, and the penny at 2 cents.—Editor.

†The name given to the headquarters of the original Wernher-Beit-Eckstein group.

change is indicated by the figures in the table below, taken from the reports of the Transvaal Chamber of Mines; to this I have added the dividend record as being through a long series of years the best measure of profits.

YIELD, PROFITS, AND DIVIDENDS ON THE RAND:

Year	Yield per ton £ s. d.	Working cost £ s. d.	Working profit s. d.	Dividends per ton s. d.
1902	2 2 0	1 5 9	16 6	10 3
1903	1 19 8	1 4 9	14 11	9 4
1904	1 18 6	1 4 4	14 2	8 1
1905	1 15 10	1 3 6	12 6	7 2
1906	1 14 6	1 2 2	12 6	7 0
1907	1 13 11	1 0 10	13 3	7 8
1908	1 11 5	18 0	13 5	8 1
1909	1 8 11	17 1	11 6	9 9
1910	1 8 6	17 7	10 6	7 1
1911	1 7 11	18 0	9 7	5 8
1912	1 9 0	18 8	10 0	5 5
1913	1 7 9	17 11	9 6	5 8
1914	1 6 6	17 1	9 0	5 8
1915	1 6 3	17 5	8 5	4 10

It will be noted that with only one exception the grade has fallen year by year and that only on three occasions has the working profit increased. These facts are brought out more clearly in the next table, in which the decrease or increase over the preceding year is shown. The figures are all the more significant since they relate only to the working-profit and take no account of increased capital changes, which have been heavy.

Year	Decrease in yield s. d.	Decrease in working-profit s. d.
1903	0 4	1 7
1904	1 2	0 9
1905	2 8	1 6
1906	1 4	0 0
1907	0 7	0 9*
1908	1 6	0 2*
1909	2 6	1 11
1910	0 5	1 0
1911	0 7	0 11
1912	1 1*	0 5*
1913	1 3	0 6
1914	1 3	0 6
1915	0 3	0 7

*Increases.

Comparisons for any individual year are not exact, since a decrease in average yield shows at once in the working-profit, while the benefit of changes made in working-conditions lags behind. For the period as a whole the mining engineer has scored, since the total fall in average yield has been 14s.9d. and in working-profit only 7s.1d. Unless the increased capital charge be taken into account it is not feasible to present an absolutely exact comparison. To meet a situation such as portrayed above, three courses are open: (1) to increase the grade of the ore by selective mining or closer sorting; (2) to decrease the cost per ton by re-organizing the industry on a basis of larger units; (3) to improve the technical practice in both mine and mill so as to lower the cost and increase the saving. All three of these plans have been tried without complete success in any direction.

Selective mining, either by leaving low-grade blocks standing or leaving side 'reef' unmined, was urged as a panacea and with great vigor about 1909-1910, but, attractive as the plan sounds when urged by an enthusiastic advocate, it must be admitted that in practice it fails to meet the situation in anything more than a limited way. A recent instance, reported by the Crown Mines, for the quarter that ended March 31 last, may be cited as typical. It will be remembered that in 1915 and the early part of 1916 there was an abundance of native labor. Taking advantage of the opportunity, itself most unusual, the attempt was made to raise the grade of the ore by taking machines out of stopes, substituting hammer-boys, and narrowing the stoping-width. The average yield per ton was increased 0.5 dwt., but it was found impossible to maintain the tonnage under these conditions, despite the fact that 37 additional faces had been opened. The total yield was less and the cost per ton higher, so that profit decreased. It was therefore decided to revert to the old method of intensive production. As I shall indicate later, the cost of merely keeping open additional faces is much larger than is generally realized, and this, together with the doubtful net value of the ore left behind, shows that there is little hope from narrowing the stope-widths in depth along the Central Rand. The whole subject was discussed informingly by W. W. Mein in a paper read before the South African Association of Engineers, and reproduced at length in the MINING AND SCIENTIFIC PRESS of September 24, 1910. Since Mr. Mein's paper appeared, results seem to have confirmed abundantly the ground he then took in favor of the wider stopes, though it is to be noted that none of the engineers who went in for selective mining have set out in detail their actual experiences.

The closeness with which it is desirable to sort is a matter upon which local opinion differs sharply despite the great tendency to standardization. So far no uniform practice has been evolved nor is there even unanimity as to whether or not sorting is desirable. It may be a coincidence merely, but on the Rand the coarse-crushing and sorting plants are seldom under the direction of the metallurgist, whose authority and responsibility begins only with the ore delivered to the stamp-mill bin. At some mines the sorting-plant is considered to be part of the mine equipment. At many the manager retains control himself and uses it as a sort of reducing and safety-valve to control the stream of ore flowing from mine to mill. Visiting a number of sorting-plants, I was impressed with the marked contrast between the irregularity of the work done by them and the general uniformity of the stamp-mill work. If one may judge from the recorded sampling of the rejected waste, there is great irregularity in the technical result. This, I believe, goes back to a fundamental condition laid down by the management, and to which both engineers and metallurgists must conform, namely, that however widely the ore may vary in gold content from day to day, the return from month to month must fall close together. The inevitable result is alternate crowding and starving of the

ore-house and consequent great irregularity in the closeness of the sorting. There are many other results of which I shall speak later, but it is sufficient here to point out that ore-sorting, despite the consideration that has been devoted to it, is still in an unsatisfactory state on the Rand. Whether it is cheaper to separate 'reef' from 'rock' that is, ore from waste, by hand in sorting-houses or to send the whole to the mill will depend in large part upon how the ground is broken and how the partings occur in the ore, and it is not to be forgotten that conditions vary greatly from point to point. It is not feasible to attempt to discriminate in the ore-house between profitable and unprofitable banket, and it is rarely practicable to pick out interbedded quartzite. At best, only barren quartzite broken in mining can be picked out. It is impossible for an outsider to say what plan is more economical on the whole and it is entirely possible in theory, as seems to be true in practice, that sorting should be profitable at one mine and not at another. If so, it is probable that this is due to methods of mining in part conditioned by differences in the lode and to costs of milling. Speaking generally, I venture the opinion that the work of sorting as now conducted is one of the weakest points in local practice. That the tendency on the Rand as elsewhere is to eliminate it, substituting larger mill-capacity with lower operating-cost, is shown by the fact that the percentage of waste sorted out has fallen with fair regularity from 17.25 in 1904 to 9.62 in 1915. Improvement in sorting-practice, if sorting is to be continued, is possible in the direction of better sizing of material, more by-passing, and to some extent in better arrangement of the plant. No great improvement is possible, however, so long as the end sought varies from day to day and the most inefficient 'boys' gravitate to the ore-house. What is needed is first a definite policy. In too many instances the matter has been controlled by the necessity of feeding a mill too large for the mine.

Whether we look to selective mining or to sorting, there seems little good in increasing the grade of the ore handled, and while we may theorize at length as to causes, the fact remains that year by year the ore treated is poorer. This decline seems likely to continue till it reaches a point equal to the lowest operating cost that can be held. Capital losses may be disguised, but in mines such as the Rand, where bonanza orebodies are not to be anticipated, it is hardly probable that any mine will long run at an operating loss.

The second method of meeting the problem of decreasing returns is by re-organization of the industry upon the basis of larger units. This takes the forms of (1) increase in the size of the actual plant-units; and (2) increase in the size of management and financial units. Both have been tried on the Rand and each plan has something to its credit, but against each there has been a reaction. The first and most natural step was to open larger mines and build larger mills so as to spread the general expense over a greater tonnage. In some cases the actual unit cost per ton was lowered by increasing the plant, in others it was only the stand-by or some other part of the 'overhead' that was brought down. Occasionally both factors were favorably influenced. The net effect was a considerable reduction in working-costs per ton, particularly in the years 1906 to 1908 when the average working-cost was decreased by 4s.2d. per ton. Since 1908, costs have remained nearly stationary; however, it increased in the years 1911 and 1912, when the most selective mining was being done. The culmination of the move toward 'wholesale' mining was in 1908. That much abused term came in for a great deal of discussion in the years 1908 to 1910, when, as I have already indicated, there rose up certain sturdy prophets who preached that the system was a delusion and a snare and the temptation to its abuse so strong that no mining man was safe if left alone within the sound of its advocate's siren voice.

In a paper before the Institution of Mining and Metallurgy in 1909, W. R. Feldtmann discussed the whole subject with notable clarity and sanity. He pointed out that wholesale mining is possible under these conditions:

1. Where it is possible to reduce the cost per ton without reducing to a corresponding extent the product per ton. The effect is then to shorten the life of the mine, but, as there is a larger profit per ton, so there is a larger working-profit during the life, as well as a higher rate of profit per annum. To which may be added that the final profit is increased by the interest earned due to the gold being won earlier.

2. Where the cost per ton is reduced and the grade is also reduced. This results in less profit per ton and shortens the life, but the total profit is increased because there is more profit per ton on the original ore, plus whatever profit may be won from the added ore.

3. Where the cost per ton is reduced but the ore added is below the ordinary cost per ton. This does not shorten the life of the mine, but it increases both the total and the annual profits so long as the ore added gives a yield above the unit-cost.

The general idea embodied in wholesale mining has been widely applied in other industries, particularly in shipping. Low back-freights are a constant feature of the transportation business. The matter has been before the courts of many lands and it has been repeatedly held that it is no injustice to other shippers for a carrier to transport at a reduceed rate such goods as would otherwise not be moved, so long as the rate does not fall below the actual cost of the transportation. Any contribution toward general expense from such a source is held to be so much clear gain, so far as the transportation company and other shippers are concerned. It is better for steamers to carry china-clay from Cornwall to America, for example, than to travel with water-ballast, so long as the rate on the clay covers the cost of loading and unloading and is more than the cost of pumping water-ballast in and out, delays being of course taken into account. The same principle applies in mining and particularly to Mr. Feldtmann's third case, which is the only one concerning which there is any material difference of opinion. When a lode has been opened and it is a question of wide or

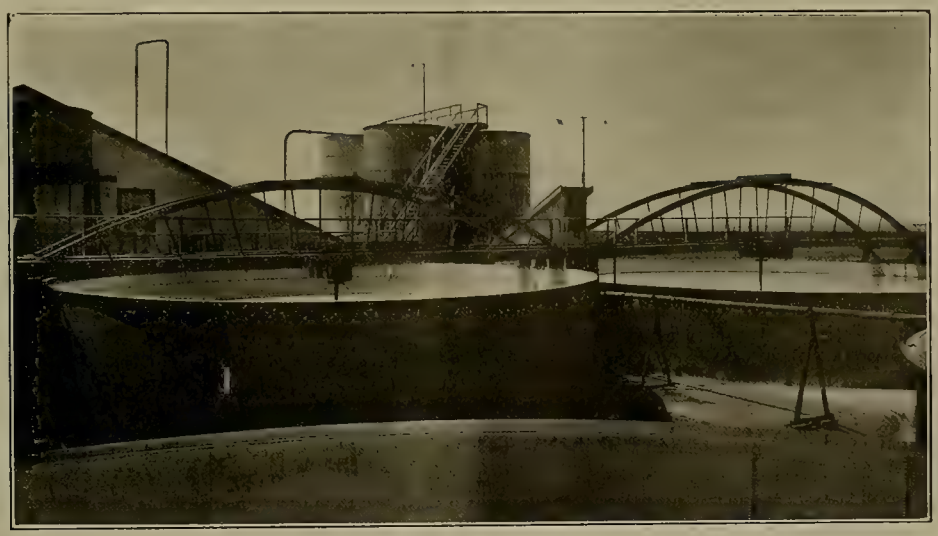
MODDERFONTEIN DEEP, SHOWING METHOD OF WORKING THROUGH TWIN SHAFTS, WITH INDEPENDENT STEAM-PLANT

narrow stoping, there can be little doubt that, so long as the additional rock contains more recoverable gold than the actual cost of saving it, there will be profit in the wider stopes. It is perhaps not so easy to determine whether or not a low-grade block shall be worked or left standing. Decision of such matters requires intelligent care and conscientious judgment, but that does not alter the principle obtaining, and in general along the Rand large-scale mining is recognized to be correct practice. A reduction plant, of course, should be run upon the highest-grade ore with which it can be steadily fed, but in actual practice narrowing the stopes has usually resulted in idle stamps or crushing waste. A large mill is a constant temptation to poor mining.

The scale of production upon the Rand is indicated by the table below, for December 1915.

Tons produced	Number of mines
Under 25,000	14
25,000 to 50,000	16
50,000 to 75,000	17
75,000 to 100,000	1
Over 100,000	1

In each case the production is by companies and not by individual shafts or mills; in fact, each is really a group of mines. Of the four large concerns, Crown Mines leads with 240,000 tons from several shafts, Randfontein Central comes second with 217,800 tons, East Rand Proprietary is third with 196,418, and Knights Deep is



GEDULD SLIME-PLANT. PACHUCAS IN BACKGROUND

fourth with 105,500. In point of fact the Rand companies operate on a basis of 1000 to 2000 tons per day—large figures, but not uncommon in mining and by no means over-shadowing.

The relationship of working-cost to tonnage is not close. The following table gives the figures of tons milled and total working-costs for a few representative properties in 1915.

RELATION OF TONNAGE TO COST, 1915

Mine	Tons milled	Working-cost s.	d.
Total and average	28,314,519	17	5.0
Crown Mines	2,501,450	16	2.0
East Rand Proprietary	1,983,600	19	1.1
Randfontein Central	2,466,520	17	11.0
Knights Deep	1,172,920	12	2.0
Rose Deep	789,700	16	11.0
Brakpan	725,168	18	0.2
Simmer Deep	769,100	15	1.0
Robinson	688,800	13	7.0
Geldenhuis Deep	638,800	21	6.0
City Deep	677,200	20	5.0
Modderfontein B	509,700	15	10.0

Even more striking is the following table quoted from the annual report of Crown Mines and covering the period of expansion of output.

Year	Tons milled	Working-cost s.	d.
1908	466,320	15	6
*1909	244,065	14	8
†1909	740,924	‡17	0
1910	1,514,000	‡18	4
1911	1,618,500	‡19	4
1912	1,920,700	‡18	4
1913	2,195,600	16	5
1914	2,287,000	15	7
1915	2,497,000	16	2

*First half-year. †Second half-year. ‡Including accumulated slime and dump treatment.

The total tonnage for the whole 17 years since the opening of the mines now belonging to Crown Mines has amounted to 15,722,215, and the average working-cost has been 17s.7d. These figures would seem to indicate that increasing the tonnage has not as yet been reflected in a lower operating-cost. This is a rather surprising circumstance, though it is to be remembered that working-costs do not tell the whole story. Referring back to the first table given in this article it will be noted that there is a considerable margin between working-profit and dividends per ton. This is represented by capital expenditure, debenture-interest, and various other expenses not included in Rand practice under working-costs. One of the confusing conditions that must be kept in mind in a study of Rand accounts is the large current expenditure regularly charged to capital account.

It remains to inquire why the expansion of output has not influenced the working cost to a greater extent. The working-cost includes two elements: unit costs and overhead. The former covers such items as breaking, shoveling, tramming, hoisting, milling, and gold realization. It is clear that such items of cost are to a large extent independent of mere quantity. In order to affect them it is necessary to make changes. To haul more tons does not mean that the cost will be lowered unless the track be improved, the trucks made larger, the motive force more powerful, and the power-cost reduced. In order to lower unit-costs by expansion, it is necessary to change methods of work and, speaking of the Rand as a whole, there has been much less of this than of mere company consolidation. In most instances Rand consolidations have only resulted in more units of production being controlled from one centre. The same methods continued to be used and often the same number of small mines continued to be worked. The only economy that could result from such consolidations would be in overhead expenses, and in considerable part these are not really reflected in working costs. Without going exhaustively into the matter, it appears that that part of the general expense assessed to working-cost in mines of 200,000 to 300,000 annual tonnage amounts to about a seventh of the total. The actual fixed expense not subject to control of the manager is larger, amounting to about two-fifths of the total. Even if, through consolidation, the admitted overhead had been materially reduced by distribution over a larger tonnage, it could not have greatly affected results. In order to show any considerable profit other than that arising from quick mining of the gold and lower capital charge per ton, it would be necessary to change methods; to make one mine out of a number of them. That has not been done on the Rand, although Crown Mines has attempted it and has spent a large sum on main-haulage roads, central deep shafts, and similar work. Randfontein Central, after building the largest single stamp-mill in the world, and an excellent mill it is, never centralized its milling until 1916, but continued to operate both old and new plants at part capacity only. It is because of such things that the big consolidations of the Rand have not made good on their anticipations; in fact, the consolidations have taken the form of joining two or more existing mines as going concerns or of adding non-producing claims to the assets of a producing mine. In the first case it has too often happened that the old plants have been continued in operation with little change. As already indicated, there could be little increase in earning power through such a consolidation. When non-producing claims are joined to a producing property it is not always realized that the present value of the claims is largely a function of time, when they begin to produce. To lengthen the life of a mine 10 years when it already has a life of 10, may be represented by the factor 2.03, but to add 10 years to the life of a mine that already has 20 years assured is represented by the factor 1.0. This matter of present value is not sufficiently understood by mine-investors and they have too often been allowed to overlook it. A consolidation that does not increase output involves temporarily a loss and if production be long deferred even the final profit may be small. In several cases consolidation was deferred until the mines in depth reached a physical change in the lode, so that figures based upon past performance proved misleading.

(To be continued)

Magmatic Segregation and Ore Genesis

By JOSEPH T. SINGEWALD, JR., Ph.D.

The preparation of the following article has been stimulated by the recent monograph on the magmatic sulphides by Tolman and Rogers.* The relations there described for the sulphides recalled so many similar relations observed in my studies of titaniferous magnetites, that the genetic conclusions based on them aroused more than usual interest. Though one of the latest groups of ore deposits to be definitely recognized, through the notable work of J. H. L. Vogt 25 years ago the magmatic segregations were firmly established as one of the major types; and it has been felt by many that the mode of formation of these deposits was so clearly understood that they constituted a group concerning the genesis of which no further question existed. More thorough petrographic studies of many examples of deposits classed with the magmatic segregations and especially the metallographic investigations of ores during the last decade, have accumulated more evidence to show that the mineralization was not so simple and did not conform strictly to the conception of a magmatic segregation in the sense in which that term had generally been employed. The time has arrived for a recapitulation of these discordant data and a remolding of our conceptions in harmony with them.

The term magmatic segregation was borrowed by the economic geologist from the petrographer, and used in the petrographic sense. Its application for the explanation of the genesis of certain ore deposits seemed plausible. It is a matter of common petrographic knowledge that no large body of igneous rock is of uniform composition, but that frequently the composition of a portion of the mass departs widely from the average. Consequently there were forces at work prior to or during the consolidation of the molten magma which caused local segregations of certain of its constituents. The nature of these forces has long been a matter of discussion and speculation, but unanimity of opinion has not been attained, and there is no thoroughly satisfactory explanation of the process known as magmatic segregation or differentiation. The usual manifestation of the phenomenon is in local accumulations of the more basic constituents of the magma. The basis for the application of this process as an explanation of ore genesis rests on other observations in the field of petrography. There is present in almost all igneous rocks a group of opaque minerals, occurring as accessory constituents and with euhedral forms, the most common representatives of which are the sulphides of iron, frequently cupriferous, and the oxides of iron, frequently chromiferous or titaniferous. On account of their commonly euhedral forms, these minerals are regarded by petrographers as the earliest constituents of the magma to crystallize. Furthermore, these minerals are concentrated together with the basic silicates in the process of rock differentiation.

There are many ore deposits, world-wide in their distribution, possessing certain common characteristics, among which may be mentioned: (1) the ore minerals consist of one or more of the accessory opaque minerals common to igneous rocks; (2) the enclosing rock is always an igneous rock, and usually basic in composition; (3) the gangue minerals of these deposits are the same as the constituent minerals of the enclosing rock; (4) the orebody frequently passes by a gradual transition into the igneous rock by a decrease in the amount of the ore minerals and an increase in the amount of the silicates. These deposits appeared to be an integral part of the igneous rock in which they are found and to represent an extreme facies of the product of rock-differentiation. Consequently they were established as an independent group of ore deposits to which the name magmatic segregation was applied. The group was subdivided by Vogt into three divisions according as the metal occurs in the native, oxidic, or sulphidic form. Segregations of native metals as primary ore deposits are of little economic importance, but the placers derived from such segregations of native platinum in the Urals constitute our principal source of that metal. Segregations of oxidic ores are the only source of chrome ores, and such segregations include countless deposits of titaniferous iron ores, as well as important deposits of non-titaniferous iron ores. Segregations of sulphidic ores include the nickeliferous and cupriferous pyrrhotites and probably a few copper-sulphide deposits. The metallic content of the segregations of the native metals usually is sparsely disseminated through the rock, and on account of the few examples of these and their minor importance, the propriety of regarding the metal as a segregation and product of crystallization from a molten magma has been little questioned. The segregations of oxidic ores usually occur well within the igneous mass, and there are so many admirable illustrations of gradation from rock with feeble concentrations of metalliferous minerals to important orebodies that no particular significance has been attached to the observation that the ore-minerals are often later than the silicates, and the conception of a segregation and solidification from a molten magma rarely has been challenged. The position of the sulphidic deposits, however, has been somewhat dubious from the start. They tend to occur on the periphery of the igneous mass; the sulphides often penetrate into the wallrock; it was early recognized that in part

*M. & S. P., April 21, 1917.

at least the sulphides are distinctly later than the rock-forming silicates, and the rock itself has frequently undergone considerable alteration. Consequently many geologists have regarded them as hydrothermal deposits. A most interesting feature of the controversy over the genetic position of these sulphidic ores has been that the nickel deposits of Sudbury, Ontario, cited by the advocates of the magmatic origin as a typical illustration of that type, is one example to which most serious objection has been raised by those contending for a hydrothermal origin. In view of the departures from the conceptions based on purely petrographic phenomena and concepts seen in these deposits, it is interesting to compare the treatment of the problem in four recent textbooks on ore deposits. These four are: R. Beck, Die Erzlagerstätten, 1909 (3rd edition); Beyschlag-Krusch-Vogt, Die Lagerstätten der nutzbaren Mineralien und Gesteine, 1910; W. Lindgren, Mineral Deposits, 1913; L. DeLaunay, Gîtes Minéraux et Métallifères, 1913. Beck, in defining magmatic segregations, says: "In many instances there took place in the rock either before or during solidification from the molten state a concentration of the ores into irregular masses.* * * In spite of the concentration into a limited space, the ores of such deposits remain, what they as scattered particles in the rocks in question are, namely, accessory constituents." Commenting on Vogt's observation that in certain of the Swedish and Norwegian titaniferous iron ore deposits the silicates formed first and then the titaniferous magnetite, he says, "those are departures from the rule otherwise prevailing for eruptive rocks that the iron ores belong to the earliest minerals to separate." In all chrome deposits which he cites for the sequence of crystallization, the chromite is the earliest constituent. Of the sulphidic deposits, on the other hand, he says, "The strict proof of segregation from a molten magma cannot always be established with the same degree of sharpness * * *. For a great many occurrences, which numerous authors consider a direct segregation from eruptive rocks, one must at least consider probable a later secondary re-crystallization of the ores by aqueous processes which brought about a partial migration and an impregnation of the wallrock." These conclusions are based largely on his own work in 1902-3 on the deposits of nickeliferous pyrrhotite and chalcopyrite at Sohland in Saxony, where he found that ore deposition took place by replacement subsequent to the hydrothermal alteration of the rock, though he believes both followed immediately after its solidification. With the exception of the treatment of the sulphidic ores, the position of Beyschlag, Krusch, and Vogt is similar to that taken by Beck, their ideas being largely those developed by Vogt. Their conception of the genesis of these ore deposits is that, "In the same manner in which larger masses of mica and feldspar can collect out of a granite magma, segregation of ores can take place, as for example magnetite, titaniferous magnetite, chromite and pyrrhotite, in such igneous rocks which normally carry these ores as accessory constituents." They call attention to the fact that the ore-minerals followed by the iron-magnesium silicates are the earliest constituents to crystallize in most eruptive rocks and they are also the constituents that migrate in magmatic differentiation. Magmatic segregation is distinguished from ore deposition, in which mineralizers participate, as follows: "The genetic difference consists essentially in that the magmatic segregations result from a single differentiation-process of the magma, whereas in the case of the pneumatolytic and contact metamorphic deposits the metallic content originally belonging to the magma is transferred to an aqueous or gaseous solution and later deposited from this through new processes." Though in most cases the two groups are considered as sharply differentiated, they admit occasional intermediate stages in which magmatic differentiation is accompanied by pneumatolytic or pneumato-hydatogenetic processes. They definitely state that the chrome ores crystallized out of a magma, and that the formation of the titaniferous magnetites "depends on a pure magmatic separation, not accompanied by special pneumatolytic processes," and that the process differs from ordinary rock-differentiation only in that it has proceeded much further. The characteristic association of some titano-magnetite with the sulphides is taken to indicate a genesis for the latter ores analogous to that of the titaniferous magnetites. In further substantiation of the magmatic origin of the sulphides is the statement that secondary alterations, such as uralitization before ore deposition or contemporaneous with it, has not in general occurred. They emphasize the fluidity of the molten sulphides and their consequent ability to penetrate into minute crevices and cracks, and accordingly they have proposed to classify intrusions of molten sulphides into the country rock under the name of injected sulphide-deposits. In such an interpretation of a number of the most important examples included under this subdivision, however, they stand almost alone.

Deposits of this character are classed by Lindgren as 'mineral deposits formed by concentration in molten magmas,' concerning which he says: "Certain kinds of mineral deposits form integral parts of igneous rock-masses and permit the inference that they have originated, in their present form, by processes of differentiation and cooling in molten magmas." Of the oxidic ores he says chromite appears in all cases to be the earliest consolidated constituent, but that the titaniferous iron ores have as a rule crystallized after the silicates; but concerning the latter he says further: "Petrographic research has long ago shown that ilmenite with magnetite is one of the earlier products of consolidation in magmas and is contained in almost all diabases, basalts, and gabbros* * *. The larger masses of ilmenite are simply facies of the rock itself produced by concentration from the same magma." Lindgren's position concerning the sulphides is almost identical with that of Beyschlag, Krusch, and Vogt, as evidenced by such statements as, "Some of the magmatic sulphide-deposits are simple basic rocks abnormal in containing much pyrrhotite, chalcopyrite and pentlandite," and, "Some deposits in which

the ore consists mainly of solid pyritic minerals present features which can hardly be explained otherwise than by actual injection of molten sulphides," in spite of his admission that "on the whole the sulphides are the latest products crystallized." In reply to the advocates of a hydrothermal origin for some of these deposits, he charges them with having confused secondary changes with primary deposition. DeLaunay's treatment of these deposits differs considerably from any of the preceding. The first five divisions of his genetic classification of ore deposits are the following:

1. Deposits of included mineral.
2. Deposits by segregation.
3. Peripheral sulphide segregations.
4. Igneous metamorphic contact-deposits of the Banat type.
5. Impregnations by diffusion from deep-seated sources, (inclusive of pyritic masses).

"Deposits of inclusions are those where a useful mineral occurs in an igneous rock in the same relation as the other constituent elements." This division is of theoretic rather than practical importance, and includes only native metals and oxides present as normal accessory constituents of an igneous rock without the intervention of mineralizers. The segregation deposits, he says, might be regarded as having been effected without the intervention of volatile constituents; nevertheless, the general opinion today is that water and probably other mineralizers have played a rôle, though he considers them formed in a medium poor in mineralizers. The ores are native metals and oxides. The peripheral sulphide segregations, he says, have usually been considered examples of true segregations which differ from the internal oxidic segregations by their position and nature. DeLaunay believes it necessary to separate them entirely from the true segregations, for there has been a concentration of sulphides not only in the rock but at its contact, and they appear to him to be a parent to contact metamorphic deposits which are formed when the wall-rock is limestone. They represent a type of ore deposition in which mineralizers are more abundant and active than in the preceding. The close relation postulated between these deposits and typical contact metamorphic deposits indicates clearly that he does not look upon them as representing a crystallization from a molten state. The mineralization of the last group is analogous to that of the fourth, the types of deposits included under it being formed where the country rock is other than a carbonate rock. It includes most of the deposits classified by Beyschlag, Krusch, and Vogt, as injected sulphide deposits. There are no sharp lines of demarcation between these groups, as DeLaunay recognizes a complete transition from purely igneous deposits to hydrothermal veins, and indicates that in some instances it is difficult to decide between fusion and solution.

In an attempt to settle some of the doubtful points concerning the mode of formation of the sulphidic ores usually classed as magmatic segregations, C. F. Tolman, Jr., and A. F. Rogers of Stanford University, as a result of a comprehensive petrographic and metallographic investigation, formulate statements which they find applicable to all the deposits studied. The most significant of these are: (1) the first minerals to form are olivine, the pyroxenes, and the feldspars; (2) magmatic alteration of the silicates often takes place prior to the formation of the ore minerals. The most common change is that of pyroxene to hornblende, but easily distinguishable from the hydrothermal process of uralitization; (3) the ores replace the silicate minerals but without reaction rims; (4) the ores are introduced one after another in the following invariable sequence: magnetite and ilmenite, pyrrhotite, pentlandite, and chalcopyrite. There is a certain amount of replacement of the earlier ore minerals by the later ones; (5) hydrothermal alteration is distinctly later than the period of ore deposition.

These observations led them to a theory of genesis more nearly analogous to that of DeLaunay than any of the others mentioned above. The fact that the ore minerals replace the silicates without the formation of metallic silicates by reaction is interpreted to mean that the ores were not introduced in a molten state, but that the same agency that brought in the sulphides removed the dissolved silicates, indicating the presence of active mineralizers. The alteration of pyroxene to hornblende is further evidence of the presence of mineralizers. Consequently they conclude that mineralization took place at a temperature below the melting point of the ores, and that they were held in solution through the agency of mineralizers. On the other hand, that ore deposition took place under conditions different from those of non-magmatic high-temperature deposits is shown by the absence of the secondary silicates characteristic of ordinary pneumatolytic and hydrothermal processes, or that, where present, they belong to a distinctly later period. They conclude, therefore, that the magmatic ores "have been introduced at a late magmatic stage as a result of mineralizers." The direct evidence presented by Tolman and Rogers is derived from the sulphide deposits, but the presence of a titaniferous magnetite in these, together with numerous references in the literature to the silicates preceding the ores in order of crystallization in deposits of titaniferous magnetite, led them to infer that the same observations and conclusions apply equally well to the oxidic ores. My own experience with titaniferous magnetites corroborates the correctness of this inference. The relations between the ore-minerals and silicates in the sulphide ores figured and described are repeatedly duplicated in thin sections and in polished sections from all occurrences of titaniferous iron ores in the United States. Titaniferous magnetite later than the silicates and replacing them is seen in nearly every section made, though many of the contacts of the two sets of minerals show what L. C. Graton and D. H. McLaughlin have recently termed mutual boundaries, that is, boundaries that give little evidence of the sequence of the minerals. Only rarely is there unmistakable evidence of primary silicates distinctly later than the ore. The replacement of the silicates by the ore has not been accompanied by

the formation of reaction-silicates and in several instances hornblendization has preceded the deposition of the ore, these phenomena being in harmony with the nature of the mineralization in the case of the sulphide ores. If segregation takes place without the intervention of mineralizers one might expect the deposit at Iron Mountain, Wyoming, to afford such an example. The orebody there occurs as an almost pure mass of titaniferous magnetite cutting the anorthositic country-rock as sharply as any igneous dike ever pictured. Yet the numerous olivine crystals which occur locally in the ore are rounded and embayed without the formation of reaction-silicates in exactly the same manner as in other occurrences. The deposit suggests an injection from a basic magma analogous to a pegmatite from one more acidic. In other cases, particularly at Grape Creek, Colorado, the introduction of ore has been accompanied by alteration of the feldspar, so that the magnetite is separated from it by a band of hornblende, indicating an activity of mineralizers greater than usual. The Minnesota deposits conform for the most part to the general rule that the ore is later than the silicates, and afford some examples of hornblendization preceding or contemporaneous with ore deposition, but also furnish instances of feldspar and pyroxene later than the ore. An excellent example of an iron ore deposit in a basic igneous rock, giving unmistakable evidence of active participation by mineralizers in the formation of the ore, is afforded by the Tofo deposit north of Coquimbo, Chile, now being worked by the Bethlehem Steel Co. This consists of a large mass of comparatively pure magnetite forming the top of a hill on the east side of the coast-range and occurring within a large area of gabbro rock. The igneous mass has undergone considerable differentiation, and various rock-types are represented in the vicinity of the orebody from highly feldspathic to almost pure ferromagnesian silicate rocks, some of which occur as dikes. The broader relations of the orebody are such as to suggest at once a magmatic segregation; but, at the same time, there are features suggestive of pneumatolysis. Adjacent to the ore are numerous stringers of magnetite in the country-rock, many having a thickness no greater than a knife-blade, which traverse it in such a way as to preclude the entrance of molten oxides. It can be explained only on the basis of the high liquidity at a lower temperature which would be imparted by the presence of abundant mineralizers.

The argument for the participation of mineralizers in the formation of magmatic deposits is plausible also from the general standpoint of ore genesis. Processes in nature representing different stages of a sequence from a given starting point are not usually separated by a hiatus. It is generally accepted today that igneous magmas are the primary sources of the metals, and modern genetic classifications group ore deposits according to their position or relation to the original source. It has been customary, however, to draw a sharp line between one group of deposits assumed to be segregated from the molten magma and solidified with it, and such groups as represented deposition of material extracted from the magma by mineralizers and constituting the pneumatolytic and hydrothermal deposits. DeLaunay's classification recognizes no such gap in the sequence of mineralization, but postulates a gradually increasing participation of mineralizers and hence a gradation from one stage to the next. It goes even a step farther and indicates that concentration of the metallic content of a magma to the extent necessary to form important orebodies takes place only when the necessary migration of the metals is aided by the presence of mineralizers, for the only group recognized by him in which mineralizers did not participate contains no deposits of economic importance, and it is only in the group in which mineralizers begin to play a part that ore deposits are represented. There have been two lines of thought in an effort to explain ore genesis, namely, that represented by the French school which has always emphasized the rôle of mineralizers, and that of the American and German economic geologists whose tendency has been to draw a sharp line of demarcation between the magmatic and the non-magmatic deposits. The work of the American and German investigators has so greatly preponderated during the last quarter of a century in the development of the science of economic geology that the views of the French school have been largely overshadowed and have not received the attention that they merit. The monograph by Tolman and Rogers will serve to establish among American economic geologists the ideas advanced by the French school. The corroborative evidence offered by the iron ores, as set forth in this paper, will serve the same purpose. A new study of the chrome-ores, with this interpretation in mind, apparently would place them in harmony with it. They now seem to be an exception, and to represent a direct segregation as the first product of crystallization from a molten magma.

BEFORE the War Germany held 28.8% of the proved deposits of iron ore in Europe, or 13% of those of the world, and France 24 and 11% respectively. In 1913 Germany worked up 47,000,000 tons of iron ore, extracting therefrom 17,500,000 tons of iron, of which 14,000,000 tons of ore, representing 7,750,000 tons of iron, was imported. In the same year France produced 21,500,000 tons of ore, of which 20,000,000 came from the Department of Meurthe-et-Moselle, three-quarters of which came from the Briey basin. Germany, before the War took 4,000,000 tons of iron ore from Briey, 3,500,000 from Spain, and 4,500,000 from Sweden. "As the War put an end to her imports from Spain," says Dr. M. Schlenker, "without the French iron ores it would have been impossible for the German iron industry to have met the enormous requirements for munitions."

IRON ORE from the Tofo mines in Chile will soon be brought in large quantities to Baltimore for the use of the Bethlehem Steel Co., in a fleet of six ships belonging to that concern. It is estimated that iron can be produced from these ores at Baltimore at a unit cost of 7 to 8 cents.

Drill-Sharpening

The United Verde mine, at Jerome, Arizona, daily requires an unusual number of drills, because the ground is excessively hard. Special arrangements have been made for drill-sharpening. These have been described by Frank Richards in the *Engineering News*. Mechanical drill-sharpeners are in use. The average number of drill-bits sharpened daily is 1800, and this requires the united effort of three men in sharpening, three helpers heating and punching steel, one man tempering, and one utility man. The work is all done in one 8-hour shift.

The dull steel is collected on the various levels of the mine, brought to the surface, sorted, and delivered to the blacksmith-shop by cars of special design. The equipment of the sharpening-plant comprises an oil-

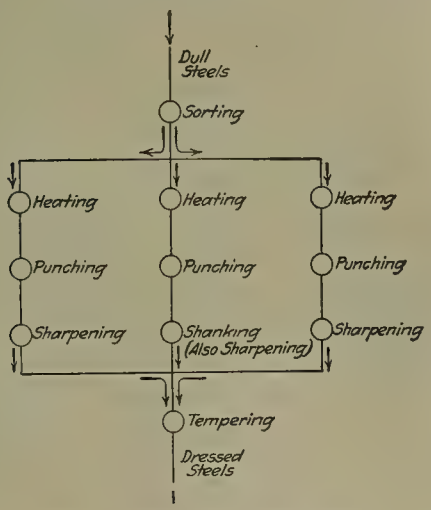


FIG. 1. SEQUENCE OF OPERATIONS.

furnace, a Davies air-operated punching-machine, a Leyner drill-sharpener, and a Davies 'blow-gun.' The work of handling and sharpening the steel has been systematized so that a dull drill entering at one end of the shop leaves ready for duty at the other end, as shown in Fig. 1. The drill-steel is hollow. The helper unloads the dull drills upon arrival, places the drill in the furnace, and when it has reached the proper heat, he removes it and places it in the punching-machine. He then passes the drill to the blacksmith, who sharpens it in the Leyner machine. When a large number of drills have been sharpened they are taken to the tempering-forge, where they are heated to the proper temperature and delivered to the slack-tub. Tempering is done by plunging the bits into water and the shanks in oil. The utility man does the grinding and dressing of the shanks. Fig. 2 shows the arrangement of the sharpening unit. The forge has a capacity for 25 drills at a time. The punching-machine, Fig. 3, has an air-plunger that is controlled by an oil-cylinder. The punch is held by a chuck that forms part of the piston. Alignment of the steel and punch is ensured by an automatic centering-clamp. The punch has increased the capacity of the sharpening-plant 50%. The steel is punched, sharpened, and blown out in one heat. Careful supervision of the shanks has greatly reduced the breakage of pistons and drills.

The Champion mine, at Platteville, Wisconsin, has

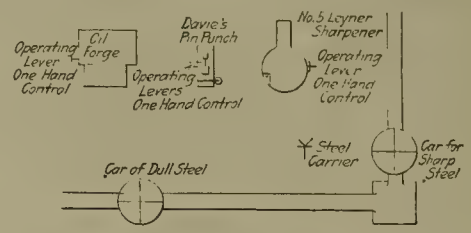


FIG. 2. THE EQUIPMENT.

a special arrangement for sharpening drill-steel, as described by J. E. O'Rourke, also in the *Engineering News*. The shop is centrally situated, as the steel for four mines is all handled in this establishment. A Sullivan sharpener and a Denver Fire Clay Co. oil-forge are in use. The dull steel, on arrival from the mines, is sorted and placed in racks arranged for the purpose.

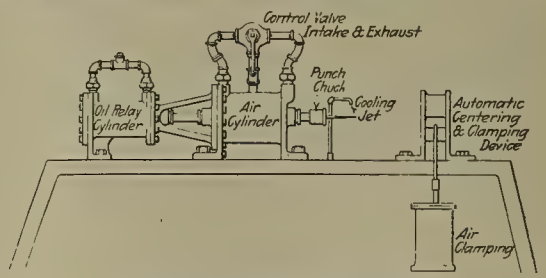


FIG. 3. PUNCH FOR HOLLOW STEEL.

From the rack it goes to the upper deck of a double-deck stand in front of the forge, as shown in Fig. 4. Nine drills can be accommodated in the furnace at one heating. The most satisfactory heat was found to be about 1650° F. To determine the proper temperature a pyrometer was used. It was held in position in the fire by means of an attachment bolted to the forge, as shown in Fig. 5. The blacksmith stands on one side of the double-deck stand and his helper on the other, as illustrated in Fig. 4. The dressing of a drill-bit requires 30 seconds. Two methods of tempering are practised. In one the temperature of the steel is lowered by partly quenching and drawing the temper to the desired color; in the

other by plunging the bits into a brine of sal-ammoniac, saltpetre, and sodium bromide, covered with six inches of No. 2 quenching-oil, the bit remaining in the liquid until thoroughly cooled. Brine causes a more rapid contraction of the granules of the steel than water, though

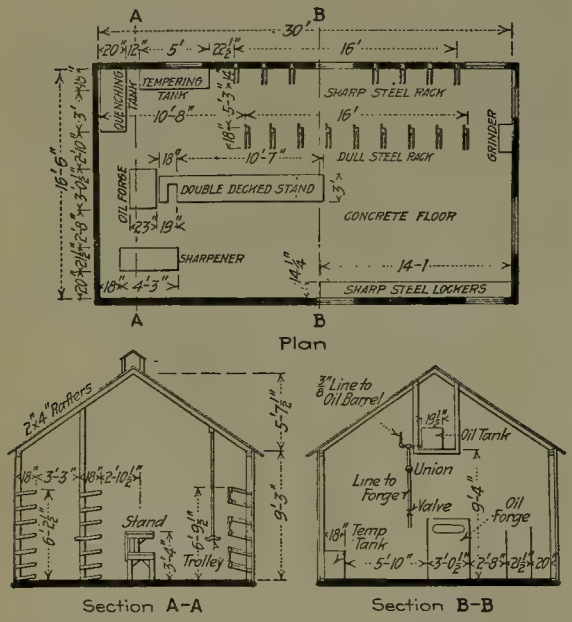


FIG. 4. PLAN AND SECTIONS OF SHOP.

this rapid action is retarded by the protecting film of oil. The bromide reduces the effect of over-heating. The other ingredients of the solution are added to soften the water. When the drill-bits have been sharpened and

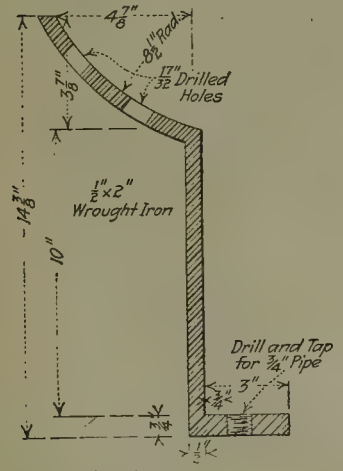


FIG. 5.

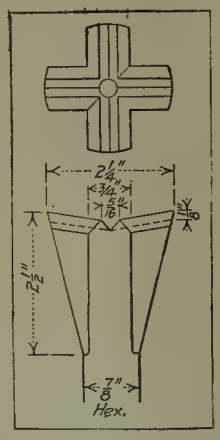


FIG. 6.

tempered they are placed on another rack. The final operation is the grinding of the end of the shank, which must be true. The grinding and truing of the shanks is done in a bench-grinder. After grinding, the drills are replaced in the rack ready for use. The oil is stored in a tank outside the building and heated by means of hot water circulating through a coil of pipe. About 50 gal. of warm oil is always available. Fig. 4 shows the plan and two sections of this shop, and Fig. 5 illustrates the attachment of the pyrometer. The type of bit shown in Fig. 6 has been found to be best adapted for the limestone of this district. The total cost of this shop complete was $2300.

Electro-Deposition of Antimony

*Antimony fluoride and free hydrofluoric acid give the best bath for the electro-deposition of antimony. The bath used contains 5% of antimony as fluoride and 3% of free hydrofluoric acid. A suitable organic addition-agent must be used to prevent a crystalline structure. These baths work easily and without deterioration or undesirable change, if the proper quantity of addition-agent is maintained and if the ordinary precautions in plating are observed. Without the organic addition-agents the deposits are rough and crystalline. The smoothest, thickest, least crystalline deposits are obtained by adding aloin, beta-naphthol, alpha-naphthol, or resorcinol. The addition-agent, 0.025%, must be added every 12 hours during the electrolysis. The deposits are gray and finely crystalline, except that too large a quantity of some addition-agents makes the deposits darker and more glossy. This result can also be produced by adding small amounts of clove oil (0.0012 cc.) along with any of the other addition-agents. The deposits are brittle, like ordinary cast antimony, hence if a plated article is bent the deposit will crack. Aloin is the cheapest of the satisfactory addition-agents. If the deposit becomes dark or shiny in color or tends to crack, less addition-agent must be used; a crystalline rough structure indicates the need. Excess causes the deposits to crack. A current of 7.4 amp. per sq. ft. is used. The deposits are less smooth with 10 amp. and, with still higher currents, they became rougher, especially when thick cathodes are being made. The voltage is 0.65 with the cathode midway between the two anodes, which were 4 to 5 cm. apart. The current efficiency is nearly 100.

THE CHINESE government plans to do her own cash-smelting. Enormous profits have been made by various companies, especially Japanese, buying up copper coins in China and melting them down, the amount of copper exceeding the money value of the 'cash.' An organization with a working capital of $10,000,000, of which the ministry of finance will advance $1,000,000, has been effected. It is planned to establish a smelting works at Tientsin, with branches in several provinces. Chinese copper cash contain from 50 to 90% of copper, and yield also tin and zinc. These coins have been hoarded for centuries and the quantities available are almost inexhaustible. Copper cash recently exported to Japan at the rate of 6000 tons per month realized a profit of $60,000,000 silver on importations from northern China alone.

*Abstract: Mathers, Mears, and Richard, Bull. Amer. Electrochem. Soc., May 1917.

Pyrite, Sulphur, and the Manufacture of Sulphuric Acid

*Up to the middle of 1915 American manufacturers were able to supply domestic needs for sulphuric acid, but as the War-demands of Europe became more acute, and more and more was demanded in the production of munitions, the call upon the makers of sulphuric acid became so great that the manufacturers had great difficulty in meeting their contract requirements while at the same time providing for the domestic trade. The effect was, war contracts being given preference, that the makers of soluble or acid phosphates were hard put to obtain sufficient sulphuric acid. This demand could be met in but one way, namely, by increasing the output of the existing plants and by erecting new ones. This was done on a large scale, with the inevitable result that the available supply of the basic material—in this case pyrite—had a direct effect upon acid-production, so that when, owing to ocean-shipment conditions, particularly during the past three months, the supply of foreign pyrite reaching this country was greatly cut down, the manufacturers of acid turned to sulphur as a base. Some of the largest makers at present are using sulphur, while others are seriously considering a change to it. This is borne out by every report from sulphuric acid manufacturing centres. To make up for the stringency of the supply of foreign pyrite, the best of which comes from Spain, and, as a consequence of U-boat patrol of the Mediterranean has not arrived in such large quantities since the German declaration of indiscriminate U-boat warfare, domestic producers have made every effort to increase their output. While the domestic output of pyrite in the first year of the War was less by about 5000 tons than that for the preceding year, the 1914 production having been 336,662 tons, the domestic production of this material in 1915 was the highest on record, reaching the total of 394,124 tons. The 1916 production figures, while not yet available, are understood to show more than a proportionate increase. On the other hand, the imports of pyrite from foreign sources held to an approximate level in 1914 and 1915, but rose last year, as the following figures will show: 1914 (long tons), 977,372; 1915, 974,616; 1916, 1,244,519. Had this proportionate importation continued during the first four months of 1917, the condition of the sulphuric-acid industry would not have been as unfavorable as it is today, but the wholesale sea-raids, and the fear of loss, combined with lack of freight-space, have cut down importations radically, as the import figures for January and February of this year indicate. For these two months there was a decline of almost 94,000 tons, as compared with the corresponding two months in 1916. These being the actual conditions underlying the sulphuric-acid industry, affecting in turn, both the production of munitions and of fertilizing materials, there is ample reason for the serious consideration given the problem, not alone of increased but of stable production of this necessary, by the Council of National Defense and the advisory bodies collaborating with it in the provision of those commodities essential to the carrying on of an aggressive war and of provisioning this country and the Allies.

Oil, Paint, and Drug Reporter, May 14, 1917.

THE COUNCIL OF NATIONAL DEFENSE has appointed numerous committees, the chairmen of those related to mining and metallurgical mobilization being as follows: steel, E. H. Gary; aluminum, A. W. Davis; asbestos, magnesia, and roofing, Thomas P. Manville; brass, Charles F. Brooker; coal-tar by-products, W. H. Childs; lead, Clinton N. Crane; mica, L. W. Kingsley; nickel, Ambrose Monell; sulphur, Henry Whiton; zinc, Edgar Palmer. The sub-committee on copper appointed by Bernard M. Baruch, chairman of the Committee on Raw Materials of the National Defense Council's advisory committee, consists of John D. Ryan, president of the Anaconda Copper Mining Co., chairman; Murray Guggenheim of M. Guggenheim's Sons, New York; R. L. Agassiz, president of the Calumet & Hecla Mining Co., Boston; Charles M. MacNeill, president of the Utah Copper Co., New York; James McLean, vice-president of Phelps, Dodge & Co., New York; and W. A. Clark, president of the United Verde Copper Co., New York. This sub-committee will supervise the production by copper mining companies during the period of the War.

THE BUREAU OF MINES rescue and first-aid demonstration car has just started from its base at Reno, Nevada, on its initial itinerary, going first to California, and thence, on May 18, to Grass Valley, on May 27 to Tonopah, then on June 3 to Goldfield, on the 11th to Aurora, and to Ely on the 18th. This is the first of the new all-steel cars completed for the use of the Bureau of Mines. Its personnel consists of Edward Steidle, mining engineer in charge, John V. Berry, foreman miner, Walter F. Pyne, first-aid miner, Donald W. Cooke, clerk. Future itineraries will include the secretaries of the Mine Operators Associations of Utah and California. In case of accident in Nevada, the car can most readily be reached by a telegram to headquarters, at the University of Nevada, at Reno. While in California summons may be sent to H. M. Wolfin, of the California Industrial Accident Commission, San Francisco.

IRON ORE exports from Spain in 1916 were larger than in 1915, despite shipping conditions. The 1916 shipments were 5,148,127 tons, against 4,509,214 tons the year before. Manganese ore exported in 1916 was 6815 tons, as compared with 9136 tons in 1915. Shipments of pyrite were 2,743,487 tons in 1916 and 2,268,223 tons in 1915. It is stated that phosphoric iron ores, which before the War went largely to Germany, have been bought in larger amounts by England and France. Such mines, which closed down after the War, have resumed operation. The inability of the producers of Spanish cupriferous pyrite to ship to the United States at the present time will release considerable quantities for delivery to England, the cinder being available as an iron-ore after extraction of the copper.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

HOUGHTON, MICHIGAN

DEVELOPMENT OF THE CALUMET & HECLA.—A GREAT AND SUCCESSFUL ORGANIZATION.—TAILING ACCUMULATION BETTER THAN A NEW MINE.—EFFECTIVE PATERNALISM.

The development of copper mining in the United States is synonymous with the operation of the Calumet & Hecla mine. It is now 52 years since old man Royale's boarding-house pig stuck his snout into an Indian pit in the back-yard of his road-house and there unearthed a cache of copper. That was practically the beginning of the Calumet & Hecla mine, and for 50 years this great corporation has been taken as the ideal mining investment of the world, for the leadership of all the copper-producing interests, and for 30 years, for the largest production of any of the copper mines of the world.

At the time of the Civil War the world's production of copper was relatively insignificant—the Rio Tinto mines of Spain being at that time the largest producer. The Civil War made a record-price for copper, the metal selling as high as 52 cents for a long time. Michigan was just coming into prominence as a producer of copper, the output being confined to so-called float copper and masses found near the surface. The Quincy mine was then the largest producer. It got out 2,000,000 lb. in one year. The Calumet & Hecla produces that much in three days now. By the way, the Quincy has paid dividends to its shareholders continuously from that time to this, missing only one year (during the Western Federation strike in 1913). A splendid record, surely.

With the discovery of the Calumet conglomerate-lode the whole system of mining copper was changed. It may be well to explain that a lode is an unstratified mineral-bearing vein. The meaning of 'conglomerate' can be found in the dictionary. In this district it is a vein of very hard rock, carrying metallic copper in particles as small as a pin-point up to lumps as large as your fist. The Calumet conglomerate lode has made it possible for the Calumet & Hecla Mining Co. to pay dividends to the shareholders of nearly $140,000,000, and to pay over $500,000,000 in wages to thousands of employees and indirectly for maintenance and operation.

In the earlier days of the development of the Calumet & Hecla property the rock was rich. Each year it is becoming leaner. To recover the ore of this lode, miners go down a mile from surface. Then they go from 500 ft. to half a mile from the shaft. The broken ore is put into cars that are trammed to the shaft and dumped into the skips, and hoisted a mile to surface. The the rock is dumped and goes through a series of crushing-processes in the shaft-house. It drops into cars, is hauled five or six miles to the stamp-mill, where it is dumped, crushed by stamp-heads having a pressure of five tons, jigged, rolled, washed on numerous tables, re-ground, again crushed, and finally put through an acid process to prevent the escape of the smallest particles of copper. This metal is hauled another mile from the stamp-mill to the smelter, where it is roasted, treated by electrolysis and cast into bars, or slabs, or whatever the customer wants. In this condition it is shipped to New York. All this is done at a cost averaging 10c. per pound for the refined metal. And for every ton of rock that is blasted down in the mine, they get just 20 lb.—1% of copper.

In the early days the rock was richer and it was close to surface. Then they got 100 lb. from every ton, and they lost 30 lb. in the stamp-mill and thought nothing of it. Now they are taking this old stamp-mill tailing and re-concentrating it and it will pay better than a new mine. The fact alone illustrates the progress of copper-concentrating at this wonderful property. With the greater depth, and with the leaner rock, it has been a problem to keep this great corporation up to its standard of earning capacity. The man who took charge of this property when it seemed to be going the way of all mines, was a copper-country product, James MacNaughton, now the first vice-president of the company. His work in the Michigan district today ranks among the greatest industrial achivements of the present generation. Today they are actually doing all this work and getting the rock into the rock-house from a mile

CALUMET & HECLA TAILING DREDGE ON TORCH LAKE

underground at a cost of $1 per ton. The miners here are the best-paid workingmen in the world. Today their average wage is $5 daily and many of them are cashing contract-checks that run better than $200 monthly for a period of a year back.

One of the most wonderful things about the Calumet & Hecla company is its paternalism. When we had a strike a few years ago, the only one in the history of the Calumet & Hecla that amounted to anything, the cry of too much paternalism was raised. But it failed, as did the last dying effort of the Moyer-Mahoney gang of Western Federation agitators. This paternalism is not ostentatiously displayed, but it is none the less practical and effective. It gives the Calumet & Hecla the finest class of miners to be found in the world. Recently you saw it announced that the four big copper producers would sell their metal to the Government of the United States for half of the going price. Everybody here believes that suggestion came from the head of the Calumet & Hecla organization.

Last summer the Calumet & Hecla celebrated its golden jubilee. It was a great family gathering. All of the Boston officials, with their families, came to Calumet; everybody took the day off with full pay; there was a parade, the like of which never will be seen again. Gold-medals were presented to every man who had worked for the company 40 years or more, silver-medals were given to those who had worked 30 years, and bronze-medals to those 20 years in the company's service. There were 168 of the gold-medal boys, and they marched at the head of the parade. There was one man who had been

continuously in the employ of the company for 50 years. Tim O'Shea is his name, and he is working every day now. Each of those gold-medals cost $187.

Last week the announcement was made that the corporation would provide a public park and athletic-field where the celebration took place last summer. The field is in the centre of the town. The best landscape-architect in Boston is going to do the job. It will be a public play-ground. That's just one. The company presented the town with the best library in the State. The late Alexander Agassiz, for years the president and moving spirit in every paternalism of the corporation, presented the school district with a manual-training school, equal to any in the United States. Furthermore, the boys have a ready market for their output, as the Calumet & Hecla pays for anything the company can use. The great amusement-place, ice rink in winter and roller-rink in the fall and spring, and a great meeting place at all times, the Coliseum, is made possible by the Calumet & Hecla's donation of the land, the heat, and the water. Practically all of the married employees of the corporation reside in company houses that rent for one-quarter actual value. They have water free, heat at a ridiculous price in many homes, large yards, pasturage for their cows (and most of them keep their own cows), and dozens of other privileges, such as services of physicians and the best of hospital-service when needed.

This corporation is the greatest of all in the Michigan district and the production is about one-half that turned out in Michigan. The other mines here operate along Calumet & Hecla plans. It is a fine example of a great corporation that has made the mining of copper at a profit one great success, while building up the best class of efficient workingmen in the world. And all the while its chief officers have been fighting the greatest industrial battle possible, for this is the lowest-grade copper district in the world—Montana, Arizona, Utah, Nevada—all of them, even the low-grade porphyry properties, mine a grade of ore that actually carries more copper per ton than the average of the Lake Superior district.

JOHANNESBURG, TRANSVAAL

DIAMOND MINING AGAIN ACTIVE AFTER A TEMPORARY SUSPENSION.—A SYNDICATE FORMED TO CONTROL THE OUTPUT.

Thanks to extensive American purchases the diamond-mining industry of South Africa ought this year to assume pre-war dimensions. In 1915 the total diamond output of the Union of South Africa was valued at £399,810 as against £5,487,194 in 1914. This, however, was only one-half of the normal production, for in 1913 the total value of the diamond output was £11,389,807. Last year, however, the mines gradually began to work again and the total production of diamonds from all sources was 2,346,330 carats valued at £5,728,391. Owing to heavy American buying, it is probable that most of the stocks of diamonds on hand have been disposed of, for while all the mines in the Union of South Africa were closed down as a result of the outbreak of war, they are all now in full work again. One of the results of Mr. Joel's visit to South Africa is seen in the fact that the leading diamond mines have formed a syndicate to regulate the output and selling price of diamonds. The result of such an arrangement is to raise the prices of diamonds, cut down the competition, and thus to enable the leading producing mines to resume mining operations.

At the end of 1916 there were seven diamond mines working in the Union of South Africa of which five were in the Free State, and only one each in the Cape and Transvaal Provinces. These mines produced in the aggregate 2,170,348 carats from the 9,232,322 loads of 16 cu. ft. each washed, the total value of the diamond production being £4,769,479. The Kimberley mines, in the Cape Province, continues to occupy the leading place, and last year produced 1,403,514 carats valued at £3,393,-311. The Orange Free State mines produced 218,261 carats worth £723,453, or 66s.4d. per carat as against an average of 488.4d. per carat for the Kimberley diamonds. The 548,572 carats produced from the Transvaal mine only averaged 23s. 10d. per carat, or a total value of £652,715.

From alluvial washings, as distinct from the rock mines, the production was 167,620 carats, but the average value was 113s. 2d. per carat, of which the bulk came from the Cape Province.

STEMPLE, MONTANA

REHABILITATION OF AN OLD-TIME PRODUCER.—MODERN EQUIPMENT AND UP-TO-DATE METHODS TO REDUCE COSTS.

The Bachelor mine is on the Continental Divide in the old mining camp of Stemple, which is situated 40 miles north of Helena. This mine was worked up to 20 years ago and produced considerable high-grade ore. It was then closed down

THE SIX MEN WHO DROVE 367 FEET OF DRIFT AT THE BACHELOR MINE, IN MARCH

on account of lack of funds to develop more ore. It lay idle until the fall of 1914, when the Royal Exploration Co. took a lease and bond on it, carried on development for six months, then erected a mill, re-built the old abandoned camp and bought the mine.

As the property has been operated by shafts and hoist it was decided to drive a long cross-cut adit and cut the vein 250 ft. deeper. This was completed by the middle of April, and the vein was cut at a depth of 1408 feet.

It is proposed to install an aerial-tram from the mouth of the adit across the canyon to the mill 1300 ft. distant.

By the driving of the new adit and the installation of the aerial-tram, total costs will be decreased 35%.

This district used to be a heavy producer of gold about 20 years ago and it is liable to be revived again by the showing in depth on the Bachelor property.

The ore from the Bachelor vein is free-milling; up to 80% is saved by simple amalgamating. J. A. Wiley is superintendent.

MONTERREY, MEXICO

THE GOVERNMENT ENFORCING THE CARRANZA DECREE OF FORFEITURE ON IDLE MINES.—A REVIVAL OF MINING AND PLANNING EXTENSION OF REDUCTION PLANTS.

According to information that has been received here from Parral and other mining districts in the States of Chihuahua, Durango, and Jalisco, the decree issued by Carranza several months ago, while he was head of the provisional government, and stipulating that unless owners of mining properties in this country resumed operations within a given time their property would be confiscated by the Government, is being enforced in a number of districts. The time of putting into effect this decree was extended twice, the date it finally went into effect being April 1 of this year. It is stated that the local Carranza authorities of a number of mining districts and communities, acting, it is supposed, under the direction or sanction of the Federal Government, have already issued permits or titles to valuable mines that were owned by Americans and others, who have been unable to resume the operation of their respective properties on account of the turbulent internal condition of affairs in the different districts. It is stated in many instances that these local representatives of the Government have turned over rich mines to Mexican laborers and the latter are taking out large quantities of ore and shipping it to the smelter at Torreon.

Practically all of the larger American mining companies in the country have either complied with the Carranza decree, as to the resumption of work upon their properties, or they have been able to obtain an extension of time in which to do so. The confiscatory policy, as it is now being applied, is felt chiefly by the smaller independent mine-owners and the decree is being enforced, it is said, against refugee Mexicans as well as men of other nationalities.

There promises to be a general resumption of mining and smelting operations in Mexico within the next few weeks if the new Constitutional Government, of which Carranza is the head, is able to maintain the existing comparatively peaceful conditions that now prevail in many of the cities and mining districts. The fact that the American Smelting & Refining Co. recently reopened its large plant at Matehuala, in the State of San Luis Potosi, and that it will soon resume the operation of its copper smelter at Aguas Calientes, is looked upon as the beginning of a general revival of the mining industry after a cessation of three or four years. The large smelting plant of the Kansas City Consolidated Smelting & Refining Co., at San Luis Potosi, is also to be reopened within the next few weeks. There is little prospect of the American Smelting & Refining Co. being able soon to reopen its large smelters at Velardeña, in the State of Durango, and at Chihuahua, as bandits are still plundering in those parts of the country.

As soon as it is seen that peaceful conditions of permanency have been established in Mexico, there will be carried out plans for enlarging the copper smelters. It is stated that the capacity of the plant at Aguas Calientes, which now consists of eight furnaces, will probably be doubled. The two smelters in Monterrey, one of which is owned by the American Smelting & Refining Co., are also to be enlarged as soon as the internal conditions of the country justify.

One of the difficulties that first must be overcome in order that the ore supply for the smelters may be brought up to the requirements when the proposed enlargements are made, is that of providing more adequate transportation facilities. One of the first things on the programme of Carranza's administration, according to advice received here from the City of Mexico, is the re-habilitation of the railroads of the country, particularly those that are necessary to the handling of the ore shipments from the different mining districts. There is a shortage of cars and locomotives, and in view of the war situation in the United States, it is said that it will be practically impossible for orders for rolling-stock to be filled by manufacturers of that country. In order to overcome this obstacle it is proposed by the Government to build large car and machine-shops where the rolling-stock, that is now in such a bad state that it cannot be used to advantage, may be re-built and new cars and locomotives constructed.

It is stated by mining men in the Guanajuato, El Oro, Pachuca, Pueblo, Catorce, and Matehuala districts, as well as in some of the more remote camps of the State of Jalisco and Oaxaca, that there is much activity in the way of mining ores. Many of the mills have been placed in operation after a long period of idleness.

TORONTO, CANADA

SILVER PRODUCTION STIMULATED BY HIGH PRICE.—FLOTATION AT COBALT, WITH POSSIBILITY OF LITIGATION.—EXTENSION OF MILLING PLANTS.—NEW VEINS DISCOVERED IN DEEP WORKINGS.

Activity in silver production has received a great stimulus from the high price of the metal, which has more than counterbalanced the falling off in the grade of the ore at Cobalt. Mining operations are being vigorously pushed and mine-owners are seeking by the adoption of more economical processes and the treating of larger tonnages to offset the lower silver content of the ore. The flotation-process is coming into more general adoption. Mr. Holt, of Salt Lake City, inventor of the Holt-Dern furnace, has been for some time conducting a series of experiments at the Buffalo and Dominion reduction plants on the treatment of flotation-concentrate, with the object of enabling the plants to ship their product in the form of bullion, instead of having to market the concentrate for further treatment elsewhere. It is stated that this experimental work is likely to prove successful. The adoption of the flotation-process, however, threatens to be attended with some legal troubles, as the Dominion Reduction Co. has been notified by Minerals Separation, Ltd., that its further use of oil-flotation in the treatment of ores will be considered an infringement of the patent rights of the Minerals Separation. The decision in the Butte & Superior case may have an important bearing on the proceedings against the Canadian companies. The Cobalt companies having oil-flotation plants in satisfactory operation are the Buffalo, with a mill of 600 tons capacity; Coniagas, 100 tons; McKinley-Darragh, 100 tons; Northern Customs, 100 tons; Dominion Reduction, 200 tons; and National, 75 tons. The Nipissing flotation-plant, of 300 tons, is still in the experimental stage. At the McKinley-Darragh the foundation for an additional flotation-mill of 250 tons capacity is being excavated. The new mill will be of the Marathon type. It is expected to be ready for operation by the end of August. The McKinley-Darragh has discarded stamps in favor of a ball-mill for crushing.

The annual report of the La Rose Consolidated showed a considerably decreased output, the production being 740,065 oz. of the net value of $449,734. The net profit was $164,774. Operating cost was 46.39c. per oz. The balance carried forward, after paying dividends, was $727,169. At the Beaver Consolidated a winze is being put down on the high-grade vein discovered on the 1600-ft. level. The main shaft of the Temiskaming, adjoining, is being put down from the 1600-ft. level to

1800 ft., and exploration at depth is proceeding by cross-cutting. The Peterson Lake has abandoned work at the Nova Scotia shaft and transferred its activities to the property formerly leased by the Susquehanna on the north-west arm of the lake, where a shaft 200 ft. deep has been dewatered and a campaign of exploration will be started.

At the Hollinger Consolidated, every effort is being made not only to maintain, but to increase production, notwithstanding the handicap of inadequate and inefficient labor. The installation of the additional equipment, which will increase the milling capacity by 1000 tons, is expected to be completed in about two months. Underground operations are rapidly increasing the ore reserves. Vein No. 58 at the 425-ft. level is maintaining its width and grade.——The Dome is pursuing a conservative policy and production is slowing down, as the mill is only being worked about two-thirds of the possible running-time. The dividend has been reduced to 10%, the reason assigned being unsatisfactory labor conditions. The agitation among the miners for an increase of 50c. per day continues, but the spirit of restlessness and insubordination among the foreign element, who are chiefly enemy aliens, has been considerably subdued by the action of the Government. A census of this class in the mining districts has been taken and the warning given that if they do not continue steadily at work they are likely to be interned. At the McIntyre great progress has recently been made. The mill is now treating about 500 tons daily, with a yield of about $10.82 per ton, and large additions have been made to the ore reserves. The drift at the 1000-ft. level is now over 1000 ft. long, the vein showing no falling off either in width or value. The main vein of the North Thompson has been cut at the 600-ft. level where it shows 20 ft. of good ore. The mill is treating 100 tons per day. At the Newray, a new vein, 15 ft. wide, has been cross-cut on the 400-ft. level.

The main vein of the Kirkland Lake has been cross-cut at the 600-ft. level, where it retains the characteristics of the upper levels. The shaft, which is the deepest in the Kirkland Lake district, will be sunk deeper. The Kirkland Midas has uncovered a promising 7-ft. vein. At the La Belle Kirkland 5000 ft. of diamond-drilling has been completed with good results. At a depth of about 700 ft. vertically the main vein was found to be 7 ft. wide, carrying a good grade of milling-ore. Several low-grade veins were cut.

The Canadian government has introduced into Parliament an important amendment to the legislation, imposing a tax on excess business profits. It provides that where annual profits exceed 15% the tax shall be increased 50% on profits over 15%, and where profits exceed 20% the tax shall be 75% on the excess over 20%. As in calculating the profits of mining companies, allowances are made for the exhaustion of ore reserves, it is not considered likely that the mining industry will be seriously affected by the change.

As a result of experimental work now being conducted at the Buffalo & Dominion Reduction Works by the inventor of the Holt-Dern process, the main objection to flotation in Cobalt seems about to be removed. Not only are experiments meeting with success in the treatment of flotation concentrates, for which the process was primarily installed, but it would also appear as though table-concentrate may be treated satisfactorily.

SUTTER CREEK, CALIFORNIA

PROSPECTING FOR OIL IN SACRAMENTO COUNTY.—THE ARGONAUT NOW THE DEEPEST GOLD MINE IN NORTH AMERICA.—PROGRESS AT THE OLD EUREKA.

Amador county people, as well as those of Sacramento county, are greatly interested in the oil-drilling about to be started at Clay station in the south-east part of Sacramento county, and if the plans of the Laguna Oil Co. materialize, an oil industry may be developed there. The company has recorded leases on nearly 15,000 acres of land in the foot-hill region, and the search for petroleum will begin as soon as the necessary outfit arrives at Clay. L. Gregor, who has been interested there for several years, secured the leases from the owners. Henry Mitau is president of the Laguna Oil Co., Scott F. Ennis is vice-president, and George W. Peltier is secretary.

AS THE OLD EUREKA APPEARS TODAY

COTTONWOOD TREES GROWING IN THE OLD EUREKA SHAFT EARLY IN 1916

The Argonaut mine now has the deepest gold mine in the county, exceeding in the present sinking the Kennedy's depth of 4012 ft. The Argonaut shaft is sunk on an incline; the Kennedy east shaft is vertical, but the Argonaut's present depth of 4667 ft. is equivalent to a vertical depth of 4041 ft., and within a month the Argonaut shaft will be put down an additional 118 ft., making its total depth on the incline 4785 ft., equivalent to 4143 ft. vertical. The encouraging feature in both of these deep mines is that the orebodies continue to maintain their size and value, the management claiming that

their best rock comes from the lowest levels. Twenty stamps of the new Argonaut mill are in operation, also 20 stamps in the old mill, while the other 20 stamps are being moved from the old mill to the new one. It is the intention to have the 60 stamps in operation in the new building within 90 days, when that plant will have a crushing capacity of 300 tons per day. N. S. Kelsey is the superintendent.

At the Old Eureka mine at Sutter Creek, locally known as the Hetty Green mine, work continues as usual. The corporation is known as the Old Eureka Mining Company, capitalized at $3,000,000. Par value of shares is $10 each. Issued, 100,000 shares. Incorporated under the laws of Delaware. W. D. Thornton, New York, president; George E. Tener, vice-president; John D. Clarke, New York, secretary; T. Walter Bean, Sutter Creek, general manager.

The depth of the main shaft is 2063 ft. The vein was stoped by the former management from near the surface to the 1800-ft. level, which is the present place of operations.

The mine had been idle for more than 30 years when the present owners began operations. The average dip of the fissure is 71°, and the vein lies at the contact of greenstone hanging and slate foot-wall down to the 1500-ft. level, below which the vein is wholly in the clay-slate.

ALASKA

DEVELOPMENT OF THE MOTHER LODE COPPER MINE PROMISING.—LARGE OREBODIES IN SIGHT.

The new two-compartment shaft of the Mother Lode has been started and is down 51 ft. but has been temporarily stopped awaiting a power-hoist, with a view to developing and opening up the lower ore zone (the zone that all the Bonanza mine workings are on). It is believed that the same conditions will be found on the Mother Lode property. A careful and conservative estimate of the probable ore tonnage and value taken at the present market value of copper and silver indicates the following:

PROBABLE ORE BETWEEN 600 AND 800-FT. LEVELS IN NEW SHAFT

Tons	Copper, %	Silver, oz.	Tons copper	Ounces silver
160,000	15	4	24,000	640,000
80,000	40	10	32,000	800,000
240,000			56,000	1,440,000

Copper value at 30c. per lb.....$33,600,000
Silver value at 75c. per oz..... 1,080,000

$34,680,000
Less mining and hoisting charges at $5 per ton.... 1,200,000

Net value at mine.....$33,480,000

The low-grade ore has been estimated as containing 15% copper and the high-grade as 40%, and while there will undoubtedly be a considerable tonnage running below 15%, so also will there be a large tonnage running over 40 or even 60%, hence these percentages will prove to be a conservative average when the ore is mined.

In the Marvelous workings the average width of the vein is 7 ft., but in the South stope, near the surface, it widened to 18 ft. for a considerable length. In the Pittsburgh North-Drift stope, there is a width of 31 ft. and the eastern wall not yet found. It has been found here that the deeper the workings go the stronger, wider, and richer the vein becomes. The present showing and future outlook of the Mother Lode exceeds anything else ever seen at any previous time since the development commenced, and what was only a good prospect four years ago is now a fully developed copper mine, with a large tonnage of rich ore extracted, blocked out, in sight, and prospective, as the foregoing figures indicate, and only lacks the mill, power-plant, and wagon-road to make it as great a producer as the Bonanza mine.

CRIPPLE CREEK, COLORADO

DEEPER MINING PRODUCING BETTER RESULTS.—NUMEROUS NEW SHIPPERS.—WATER IN DRAINAGE TUNNEL FALLING OFF.

Deeper development plans are in preparation throughout the entire Cripple Creek district, where many of the principal producers are sinking, and many leasing companies are opening up old producers with this idea in mind. A larger tonnage is predicted from the deeper development of the district for the balance of the year.

Sinking is in progress at the No. 2 shaft of the Portland Gold Mining Co., on Battle mountain, and it will be continued to the same depth as the Cripple Creek deep drainage tunnel. When sinking was resumed the depth of the shaft was 1935 feet.

The Granite Gold Mining Co. also is sinking in the Dillion shaft, with an approximate depth at this time of 1675 feet.

The Excelsior Mining, Milling & Electric Co., operating under lease the Llewellyn shaft, on the Longfellow group of the Stratton Cripple Creek Mining & Development Co., has contracted for the sinking of this shaft from the present depth of 235 ft. to an ultimate depth of 800 feet.

In the vertical shaft of the Modoc Consolidated Mines Co., raises are being cut from the seventh and ninth levels of the Modoc incline shaft, and when the connections have been made the vertical shaft will be several hundred feet deeper than now.

A raise from the 1000-ft. level of the Portland No. 2 shaft will be started after the surveys have been made to connect with the Rose Nichol shaft. The Camp Bird Gold Mining & Development Co. is operating this property under a six-year lease from the Rose Nichol Gold Mining Company.

Lessees Heckler and Denny are sinking a new shaft from surface on the Lucky Corner claim to intersect the Lucky Corner flat-vein at an approximate depth of forty feet. The Lucky Corner claim is owned by the Doctor-Jack Pot Mining Co. and is situated in Squaw gulch.

Sinking will be resumed shortly at the Last Dollar mine, on Bull hill, by the Catherine Gold Mining Co., under direction of Charles Walden, president and general manager. The lower workings were not entered until about May 5 on account of accumulated gas, which was removed by means of fans and compressed air. The bottom level is established at a depth of 1500 feet.

Weir measurements at the portal of the Roosevelt deep drainage tunnel, made last week by Engineer Countryman, recorded the lowest flow since 1915, being 6280 gal. per minute. The heaviest flow recorded, late in 1915 and in the spring of 1916, was 17,000 gal. per minute. Progress of 6½ ft. is made daily with one shift drilling.

The Hahnewald brothers, operating under lease the El Paso Gold King mine in Poverty gulch, commenced shipments this week. Sinking will shortly be started by these operators.

Lessees of the Elkton Consolidated Gold Mining Co. shipped 1000 tons of ore of an average value of $18 during the month of April. This amount does not include dump-shipments and outside leases, being produced from the main Elkton shaft.

The Trilby mine, operated under leasing plan, is shipping at the rate of a car a week. Von Wald & Co. and E. J. Williams are the only lessees producing ore.

The Beacon Hill properties of the Commonwealth Mining & Milling Co. after a long period of idleness will commence shipments from a new ore-shoot opened up by Carnduff & Duncan, lease operators.

The Cripple Creek district shows some of the effects of the general labor shortage, but with a raise in wages and better conditions prevailing the situation is not one to worry executives. All $3 men received a raise of 50c. per day, while $4 men received an increase of 25 cents.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

(Special Correspondence.)—At the Beatson mine of the Kennecott Mining Co. the mill is being enlarged to twice its size, making a capacity of 1500 tons per day. This new unit will be in operation some time the coming summer.

A large amusement hall, including a 'movie' and bowling-alleys on the ground floor, and club-rooms on the second floor, has been completed for the employees. A picture-show is given twice a week and is very popular, since heretofore there has been no amusement of any kind upon the island. The Beatson is employing 350 men.

W. A. Dickey, of Landlock, has taken an option and lease on the Girdwood property, which has not been worked since 1907 when shipments were made. It adjoins the Beatson mine of the Kennecott company on the north and is supposed to be a continuation of the Beatson orebody. Development consists of tracing the orebody on the surface by open-pits for about 700 ft. along the vein, which on the surface is from 6 to 16 ft. wide and averages 5% copper in a chalcopyrite ore. The vein has been tapped at a depth of 245 ft. by a 700-ft. cross-cut adit. Where this adit intersects the vein it was barren, but 50 ft. south, in a drift, ore was found. A stope 50 ft. long was opened up, the vein being 16 ft. thick and averaging 5% copper. On this level considerable work was done south of the stope, but no ore was found. About 100 ft. south of the stope a raise was put through to the surface. Fifty feet above the floor of the stope the vein was opened up by a cross-cut from the raise and found to be about the same in width and value as that in the stope with a little greater length to the shoot. No more ore was found in the raise until within 50 ft. from the surface. The raise came out in the vein on the surface. This would indicate a shoot of ore 50 ft. long and 16 ft. thick in the stope, which appears to extend 50 ft. above the floor as provided by the raise. Mr. Dickey is putting in a wharf, repairing the old tramway and bunkers, and expects to commence shipping ore in July. Under his bond and lease he is obliged to do specified development work in return for the privilege of taking out the ore, and in addition pays Mr. Girdwood a royalty on all ore shipped. He expects to ship from 1000 to 1500 tons per month.

La Touche, May 4.

(Special Correspondence.)—The Granite mine, at Hobo Bay, closed down on May 1. The reason given was the high cost of fuel-oil used for driving the mills and compressors. It is said that the management contemplates the installation of new machinery to obviate the high cost of fuel, but that it is not economical to make such change at this time owing to the high cost of machinery. The Granite is a little gold mine operated by B. F. Millard, and has been running continuously for the last three years. It is equipped with a 10-ft. Lane mill and a 10-stamp mill. From 50 to 75 men are employed.

Port Wells, May 4.

(Special Correspondence.)—The Thomas-Culross property on Culross island has completed the installation of an 8-ft. Lane mill driven by hydro-electric power and will commence mining and milling within a month. The mine development consists of a 450-ft. adit drift on the vein, gaining 200 ft. of backs at its face. This company is working 20 men.

Culross Island, May 4.

(Special Correspondence.)—Development is progressing on the Daly-Bennett property, an adit having been driven on the vein 400 ft. This vein is an acidic dike from 3 to 4 ft. thick, and contains little quartz veins at frequent intervals. The quartz carries visible gold. The dike rock itself also carries good value in gold. This property is in charge of B. C. Wiltse and is being financed by Pittsburg people, including Michael Wall, who visited the property recently.

Bettles Bay, May. 4.

(Special Correspondence.)—The Granby Mining Co. is crowding production to the limit of available boat-capacity on the Midas property on Solomon gulch, nine miles from Valdez. They are breaking 200 tons of ore per day, which is shipped to the smelter at Anyox, B. C. It averages about 6% copper.

Valdez, May 4.

The Alaska Mexican Gold Mining Co. reports returns for March as follows: Ran 26 days 1 hour 59 minutes. Crushed 6685 tons, saved 212.34 tons of concentrate. Estimated gross value of concentrate, $11,888.59. Realizable value, $11,769.71. Operating expenses, $10,676.87; estimated operating profit, $1092.84; construction expenses, $4308.69; estimated loss, $3215.85; income from other sources, $5062.63. Ore yielded $1.78 per ton. The Mexican mill also crushed 8120 tons of ore from the United company's Ready Bullion mine.

The Alaska United Gold Mining Co. reports for the month of March as follows: Ready Bullion mill ran 30 days 19 hr. 29 min.; by water-power 6 hr.; by electric power, 30 days 13 hr. 29 min. The 700-Ft. Claim mill ran 30 days 12 hr. 39 min. Ore crushed by Ready Bullion mill, 23,905 tons; by Mexican mill, 8120 tons; from Ready Bullion mine, 32,025 tons; from 700-Ft. Claim, 24,675. Concentrate saved: Ready Bullion, 797.09 tons; 700-Ft. Claim, 506.75 tons. Estimated value of free gold saved from 700-Ft. Claim, $7096.41; estimated value of concentrate from Ready Bullion mine, $63,073.82; 700-Ft. Claim, $53,461.12. Realizable value: Ready Bullion, $62,443.09; 700-Ft. Claim, $52,926.51. Operating expenses: Ready Bullion, $48,253.18; 700-Ft. Claim, $68,223.22. Estimated operating profit: Ready Bullion, $14,189.91; 700-Ft. Claim (loss), $15,-296.71. Construction expense: Ready Bullion, $5223.89; 700-Ft. Claim, $9708.15. Estimated net profit, Ready Bullion, $8966.02; 700-Ft. Claim (loss), $25,004.86. Other income, Ready Bullion, $2040.75; 700-Ft. Claim, $2040.75. Yield per ton of ore: Ready Bullion, $197; 700-Ft. Claim, $217.

The Alaska Treadwell Gold Mining Co. for the month of March reports the following:

The time run by 225 stamps in the 300-stamp mill was 30 days 11 hr. 57 min., running on electric power.

Tons ore crushed	37,828
Tons concentrate saved	785.95
Estimated gross value of free-gold	$ 9,245.03
Estimated gross value of concentrate	70,943.18
Estimated gross total production	$80,188.21
Estimated total realizable value	79,386.33
Operating expenses	46,445.29
Estimated operating profit	$32,941.04
Construction expenses, etc.	16,641.09
	$16,299.95
Other income	11,838.74
Estimated net profit	$28,138.69

Yield per ton of ore milled, $2.12.

ARIZONA

Cochise County

(Special Correspondence.)—There has been more than the usual interest manifested in the Bowie mining district the past month, and a number of prominent mining men and engineers are in this field making examination, with a view either to purchase or to lease. J. W. Sterling, of the Willie Rose Copper Mining Co. of Bowie, made a trip to the Cochise Head property this week with A. D. Mitchell, of Utah. The property comprises a group of 21 claims at the mouth of Wood canyon, south-east of Bowie. The vein is 200 ft. wide, containing disseminated copper glance, in places running as high as 4% copper at the surface.

The Willie Rose mine is closed down temporarily during the installation of a hoist and other machinery. The mine has been shipping high-grade glance ore the past two months; the ore-shoot is in a lime-spar vein 200 ft. wide, and ore down to a depth of 65 ft., has been shipped from it. Machinery is now necessary before again operating. The owners are now considering a proposition to give a lease with an option to purchase the mine.

The Helens Dome Mining Co. of Bowie, is sinking on the cross-fissure of the silver-lead vein on its property, and is breaking some very good ore. J. W. Sterling, of Bowie, has been making a number of examinations in the district and reports having found several good properties, among them the Silver Strike, in Apache pass, which shows a body of silver-lead ore running $76 per ton. There is a large body of ore, which should prove valuable at the present price of lead and silver.

Bowie, May 12.

Mohave County

(Special Correspondence.)—Operations will be started on the I X L in a few days. The property adjoins the Wrigley Sulphides Company's ground on Stockton hill and has produced a large amount of good ore.

The Minnesota-Connor is to be started up in a short time, New York capitalists having just acquired control of it. The property has much merit and locally it is thought that it only needs intelligent development to make it a producer.

The Gladstone has again been unwatered and is to be placed in operation at once. F. C. Smith and W. B. Twitchell, of the Hidden Treasure, are identified with it.

The power-line is being built to Jessie Knight's Bullion Hill property, though there may be some delay caused by lack of transformers. The machinery for sinking is all in place ready for the electric-current.

San Francisco and Los Angeles mining men have made a 10% payment, of $6000, on the Silver Hill property and it is considered a certainty that the deal will be consummated.

A. G. Stearns is here from Los Angeles to start work on a second custom-mill, which will be situated on the east side of Silver hill, near the Santa Fe tracks. It will be of 150 tons daily capacity.

The Steffy custom-mill is expected to be in operation before June 15. Nearly all the machinery has been hauled from the railroad to the plant and work is being pushed. The camp will be benefited by this plant early in its career.

The Copper Age mill is nearly ready and is expected to go into operation by the first of June.

The George Washington mine, at Mineral Park, is breaking ground for a mill. A find of rich silver ore is reported from there.

The Puzzle has started a second shaft, which will connect with the bottom of the incline winze in which rich silver ore was recently discovered. The connection will be made at a depth of 100 ft. A hoist is to be placed on this shaft as soon as it can be secured.

The Schuylkill shaft has reached the 800-ft. point and a sump is being cut and cross-cutting will be started for the vein. If the ore is found as good as expected, a mill will be erected on the property. This company has just purchased a water right from Sam Rhea.

A communication from Swansea indicates that W. A. Clark is planning to build a railroad from that point to connect with his Salt Lake route, passing through Chloride. This would give this district direct rail connection with the Utah smelters.

The 40-ft. shaft on the Bobby Burns is yielding native copper. From three small panfuls of dirt nearly a handful of copper nuggets was recovered. There is a heavy flow of water in the shaft and the extent of the find cannot be determined without further work.

Chloride, May 14.

CALIFORNIA

Del Norte County

Henry Pattison of Crescent City has been permitted to appropriate 3 cu. ft. of Hayden gulch tributary to Hurdy Gurdy creek for mining purposes, by means of a dam 20 ft. high, 30 ft. long on top and 16 ft. at the bottom, to be constructed of timber, rock, and brush.

Inyo County

A permit has been issued by the State Water Commission to Arthur and H. A. Nobles, of Bishop, for 1½ cu. ft. per second of a spring for mining and milling purposes at their tungsten mines. A pipe-line a mile long will conduct the water to place of use at an estimated cost of $1500.

Charles E. Knox, of Berkeley, has been granted a permit to take 0.04 cu. ft. per second of Burro or Willow springs, and of Rest or Alkali springs, for mining. The works consist of a small concrete dam and a pipe-line 8 miles long.

Shasta County

(Special Correspondence.)—The Victor Power & Mining Co. has changed its plant so that it is operated with electricity instead of steam as formerly. For five months of the season the company derives its power from a flume and ditch-line and for the rest of the year a Diesel-engine has been installed to furnish power. The deep Midas shaft is in the process of being unwatered and development has been carried on in the abandoned levels of the mine and some encouraging results have been obtained; experiments with flotation are being made on ore in the dumps of which there is about 700,000 tons with an average value of $1.50; the value, by screening, can be raised to $3, and if flotation can be used will make the dumps a valuable asset. Recently an auto-truck was put into service to handle the freight of the company between the property and the railroad 50 miles away. In years gone by the Midas has been a large producer of gold.

Knob, May 16.

(Special Correspondence.)—The 800-acre Menzel ranch, across the Sacramento river and north from Redding, has been acquired by El Oro Dredging Co., of Oroville. Prospecting has been going on for several months with drills, and 100 holes have been sunk to bedrock. It is stated that a large dredge will be built there.

The L. Gardella Dredging Co. is preparing for the building of a second dredge on Clear creek, four miles below Redding, near where No. 1 boat has been operating successfully for a year. It is planned eventually to operate four dredges in this vicinity, as drilling has proved the gold-bearing gravel to be more extensive than originally was anticipated.

The Texas group of 13 quartz claims, near Whitehouse, has been purchased by Robert A. Kinzie and associates, of San Francisco, and orders have been placed for pumps. The old workings are being cleared and it is planned to erect a mill and flotation-plant, as considerable medium-grade ore is exposed.

The Noble Electric Steel Co. has increased the force at its Heroult electric-smelter, and plans to have five furnaces in operation within 30 days. Three will be utilized in the pro-

duction of ferro-chrome, and the two others in making ferro-manganese. It is understood the company has recently secured control of a large manganese property. W. W. Clark is superintendent.

Twenty teams are grading for the $100,000 flotation-plant to be erected by the Afterthought Copper Co., at Ingot, where materials and equipment are beginning to arrive. An office-building and cottages for employees are under construction, and repairs to the mine workings have been completed. There are 150 men on the pay-roll.

Much new work is going on at the Bully Hill copper mines, and it is reported the management will soon start the erection of a flotation-unit. The ores run high in copper and zinc, with some gold and silver. Developments are principally at the Anchor shaft.

Redding, May 17.

Siskiyou County

B. N. Russell, of Weed, has been given a permit to take 3 cu. ft. per second of Dutch creek tributary to Bear creek for placer mining. The work consists of a dam 15 ft. high, 50 ft. long on top and 10 ft. at bottom, of loose rock and timber and a main ditch 3½ miles long. The diversion is near Gottville.

J. W. and H. H. Chapman, J. Ronning, and J. L. Peterson, of Callahan, take 1 cu. ft. per second of Mule creek tributary to east fork of Scott river, for the generation of power for the grinding of ore.

Trinity County

The State Water Commission has issued a permit to L. S. Paulsen, of Lewiston, for 30 cu. ft. per second for one diversion and 20 cu. ft. per second for another diversion of Rush creek tributary to Trinity river for hydraulic mining. The main portion of the works is a ditch 6½ miles long. The estimated cost of both diversions is $7000.

COLORADO

Boulder County

(Special Correspondence.)—T. E. Shepard has gone to Gordon Gulch where he will have charge of the hoisting-machinery at the Oregon mine.—The U. S. Gold Coin Co., at Sugar Loaf, has resumed development work on its mine.—W. J. Bey and his partner, on Bryan mountain, have found some high-grade tellurium ore, of which a good-sized vein is exposed in the shaft. They soon will put in machinery.—Otto Victor has the most promising silver-lead proposition ever exposed in Boulder county on Tennessee mountain, one and one-half miles below Eldora.——The Up-to-Date mine, at Caribou, is shipping a profitable grade of silver ore.——Emil Schnaeke has a large body of medium-grade ore. A mill is required on this property.——The Dixie mine is getting out some high-grade gold ore.

Eldora, May 14.

Park County

(Special Correspondence.)—The mining district of Alma derives its name from the town of Alma, which is on the east side of the Mosquito range, nearly opposite Leadville, and is reached by a branch of the Colorado & Southern railroad. Interest in this district dates from before the discovery of gold in California gulch in the Leadville district. Mining operations have been carried on here since the early seventies, though these operations have undergone many vicissitudes. Taken as a whole, the result has been rather disappointing, but in the majority of cases good value in precious metals has been produced, and all indications point to the presence of valuable orebodies still unworked, which may be made profitable with the application of economic methods of mining and treatment.

The chief value of the ore is in its gold and silver content; lead, copper, zinc, and tungsten also are found in paying quantities. There is plenty of vacant ground for the prospector, and many opportunities for capital. Milling and smelting have been carried on here in the past in a small way, and the outlook is good for much activity along these lines this season. At present the camp is laboring under the handicap of a lack of electric-power. For awhile this spring it seemed almost a certainty that the Colorado Power Company would extend its line here from Breckenridge over Hoosier pass, but complications arose which defeated these plans. However, this may be accomplished within the coming year.

The Hockhocking mine and mill have been closed since February 1, but will resume operations within a few weeks. The steam-plant at this property is being replaced by oil-engines of the Fairbanks-Morse type. The mill requires 60 hp., which is divided into four units. Four stamps are used, followed by four Wilfley concentrators, the slime overflow from the double-cone classifiers being treated by a vanner. The tailing from the four Wilfleys is re-ground in a Standard ball-mill. A new Frenier pump is to be used to lift the battery-pulp to the double-cone classifiers. The mill is equipped to handle 35 tons of a lead-iron-zinc ore rich in silver.

The Magnolia mine, on North Star mountain, is under option and lease to L. L. Davis, of Denver. Development of the mine began late last fall and now a good tonnage of mill-ore is in sight. As soon as the weather will permit, the work will be resumed on the tramway from the mine to the old Eddie mill in the gulch near Montgomery. The tram, when completed, will be 4000 ft. long with a capacity of 40 tons of ore in eight hours. The mill has been repaired and is in first-class condition, and will handle 40 tons of ore in 24 hours. The cyanide process will be used, the ore being oxidized quartzite.

The Centennial mine is being worked by J. Elfstrand, and two cars of $75 ore are ready for shipment as soon as the road is open. A. Lundstrom reports a good showing of ore on the Winona. It is reported that the old Ling mine will be reopened this summer under company management. The No. 5 adit will be driven ahead from the south side, 400 ft. to connect with the north-side adit at the same level. This tunnel is expected to cut the ore-shoot known to exist below the third level.

Alma, May 14.

San Juan County

Kramer, Pearson & Giono, who are operating the Congress mine, in Red Mountain district, under lease, during March let a contract for the sinking of a 50-ft. shaft, which was finished by May 1. This gives them a 100-ft. shaft from a 200-ft. cross-cut that was started at the 405-ft. point of the opening shaft, says the Silverton *Miner*.

This new work has opened up a large territory that is rich in mineral and assures sufficient tonnage to keep a full crew busy breaking ore for the remainder of the year.

While working on the 405-ft. level, an immense body of gray copper was discovered. Following this the lessees decided to let a contract for the sinking of the shaft, and when the shaft was down 100 ft. they were in ore. The lessees are now considering letting another contract of 100 ft. either to sink or drive and probably both.

During the winter months the Congress K. P. G., as this lease is known, was one of the heaviest shippers from the Red Mountain district, being credited with a total of about 40 carloads of ore, some of which is said to have been very rich.

MONTANA

Silver Bow County

With an approximate average of 27.9c. per lb. for the copper settlement prices for the month of April, the $4.75 wage-scale for the next pay-day in the Butte district is assured. The average was so dangerously close to the 27½c. mark, at which the wages automatically drop to $4.50, that a drop of a cent or two in the copper quotations for any one day might have lowered the scale.

FERGUS COUNTY

At a recent meeting of the board of directors of the Barnes-King Development Co. it was proposed to remove the offices of the company from Kendall to Butte, and to this end the consent of stockholders is being sought, the votes of the holders of two-thirds of the capital stock being necessary for this. The report of the company for the first quarter of the present year shows the following:

Balance, December 31, 1916	$109,120.26
Receipts during first quarter	232,100.65
	$341,220.91
Disbursements	$221,538.92
Balance, March 31	$119,681.99

NEVADA

ESMERALDA COUNTY

(Special Correspondence.)—The Jumbo Junior Co. has started development of that part of the Kewanas ground recently taken under lease. The area is 150 by 600 ft. and is being worked from the 880-ft. level of the Jumbo Junior mine. The rich orebody mined in both the Jumbo Extension and Jumbo Junior mines apparently enters Kewanas territory at this point, and some good ore has been already exposed. From its own property the Jumbo Junior Co. is preparing shipments to the Goldfield sampler, hoisting through the Velvet shaft of Jumbo Extension.

The discovery of high-grade ore in the winze from the 600-ft. level of the Laguna mine, of the Goldfield Consolidated, is attracting interest. The winze was sunk in the south-east part of the mine and ore averaging around $150 per ton in gold and copper was found. This ore is going to the flotation-plant. The Mohawk continues to yield a heavy tonnage of fair-grade material. From the territory recently leased from the Jumbo Extension low-grade copper-gold ore, with occasional seams of high-grade, is being sent to the flotation-plant. The company is again treating approximately 1000 tons of ore daily, divided about equally between the cyanide and flotation-mills.

It is probable that operations will be resumed at the Lone Star in the near future. Control of the company has passed into the hands of Nathanial H. Wheeler, of New York, and Thomas W. Kendall, formerly with the Goldfield Consolidated, has been appointed resident agent and manager.

The Atlantic company is shipping 300 tons of smelting ore per week, and expects to deliver 100 tons per day to the Garfield Consolidated flotation-plant within a few days. It is officially stated that the orebodies are proving somewhat higher grade than sampling indicated.

Goldfield, May 17.

(Special Correspondence.)—The Jumbo Extension Co., at Goldfield, has resumed work from the Velvet shaft to find the extension of a rich shoot in the Laguna vein. The Goldfield Consolidated recently intersected a rich stringer in a part of the Velvet claim leased from the Jumbo Extension, and is sending a heavy tonnage of flotation-ore from this point to its mill. To reach the extension of the shoot the Jumbo Extension Co. started a raise from near the 700-ft. level, and is also increasing developments on the 790-ft. level of No. 1 shaft. A fair tonnage of good ore is being drawn from the latter workings.——Prospecting with a Calyx drill is proceeding at the Diamondfield Black Butte mine, in the expectation of intersecting the shale-latite contact at a depth of 1000 ft. Any favorable indications will be followed by developments. Several lessees are active, and the Campbell lease is making occasional shipments of $100 to $200 ore from the 150-ft. level. Prospecting is being carried on to find the lost Quartzite vein, which yielded over $500,000 in the early days of the mine.

HUMBOLDT COUNTY

(Special Correspondence.)—The rich shoot opened recently on the 800-ft. level of the Rochester Mines property is improving as work advances. In the hanging wall three more feet of ore has been opened, assays averaging around $150 per ton. Five drills are operating at this point, which is the deepest working-level in the district. Driving has begun from the 900-ft. level to seek the extension of the rich ore on the level above. Ore showing free gold and native silver has been found in the north drift from the 700-ft. level. The aerial-tramway is in operation, transporting 200 tons daily from mine to mill.

At the Rochester Combined property a 100-hp. compressor, electrically operated, has been added to the equipment, and work has commenced on the Maynaugh tunnel of the Happy Jack group. In the Shepherd group a second cross-cut from No. 1 adit is out 58 ft. and has opened ore of excellent character the entire distance. According to official statements, assays range from 34 oz. silver and $3.50 gold to 108 oz. silver and $8 gold. Preparations are being made to start a new adit on the Link No. 1 claim to open at depth the vein disclosed near surface. At the head of the canyon the Christmas adit has tapped the source of the springs, and is supplying 80 gal. of water per minute. This will be used for the mill, for which excavating is proceeding rapidly.

The orebody recently opened on the 100-ft. level of the Bonanza mine of the Winnemucca Mountain Co., near Winnemucca, has been cut at the 200-ft. point, 175 ft. west of the shaft, and is found to carry stephanite and hornsilver. On the 100-ft. level the vein is 21 ft. wide, with a pay-streak of 2 to 4 ft. of rich ore.

The cross-cut from the 800-ft. level of the Seven Troughs mine is out 28 ft. from the shaft and is expected to intersect the vein exposed on the 700-ft. level within 35 ft. Shipping and milling-ore is coming from the No. 2 stope on the 700-ft. level. The last car shipped assayed $67.50 in gold and $61.76 silver per ton.

Rochester, May 12.

LANDER COUNTY

(Special Correspondence.)—The Antimony & Silver Mines Co. is installing a 60-ton Denver quartz-mill at its mines near Galene, a short distance from Battle Mountain. The plant includes amalgamating and concentrating equipment and is designed to treat antimony ores, in addition to the gold-silver ores of three different mines controlled by the corporation. In the main property, J. H. Stallings, the manager, states that 1000 tons of gold-silver ore, assaying $15 to $40 per ton, is blocked out. A test shipment of antimony ore has been made from a second group, and a large amount of low-grade material is ready for milling.

The Kansas City Consolidated Mining Co. is planning to erect a mill this summer at its property at Bruner, 14 miles from Ione. The mine has a shaft 375 ft. deep. The ore contains gold and silver, and 4000 tons, averaging around $20 per ton, is ready for treatment. The company has purchased the water rights on Labean creek, 11 miles from the mine. H. W. Bruner is manager.

Battle Mountain, May 18.

LINCOLN COUNTY

(Special Correspondence.)—An impetus was given to the mining of platinum-palladium ore in the Boss mine and adjacent prospects by a Washington dispatch to the effect that Secretary of Commerce Redfield has instituted a search in the hope of discovering new sources of platinum. It is said that agents of the department have been instructed to make a careful survey of all platinum deposits in Nevada, Australia, Borneo, Tasmania, Russia, Colombia, and other countries. This survey is the third step in the programme to exploit platinum. The first was to conserve all the platinum possible and to make use of platinum that is a by-product of the mints of

the United States. Early in the week it was learned that the secretary had a conference with representative jewelers led by George H. Kunz, of Tiffany's, New York. The secretary requested the jewelers to refrain from the making of jewelry involving a large use of platinum. The second step is to furnish technical assistance in the development of the new platinum deposits in the Boss mineral district near Goodsprings, where it has been found practicable to extract the platinum from the ores by a leaching process.

The process referred to is a chloridizing roasting and leaching of the complex Boss ore which contains copper, gold, silver, platinum, and palladium, with some bismuth and other rare metals. Other properties near the Boss that have found similar ore but are still in the prospect stage are the Platino Mines Corporation, the Oro Amigo Platino, and the Scottish Chief group.

Salt Lake capital is showing an active interest in the possibilities of Goodsprings. During the past week, C. B. Stewart and J. B. Jenson, of Salt Lake, purchased the Copper Metals property in Clark Mountain. This property has a 90-ft. shaft, well timbered and equipped with a hoist, and the copper-silver ore on the dump is of good grade.

The Ironsides is at present installing a hoist and straightening its shaft. This mine, which is controlled by Iowa people, has developed a considerable amount of 14 to 20% copper ore.

Vanadium oxide is still found in quantity in the Goodsprings Bill Nye mine, one of the steady shippers of 38% zinc ore. Testing of the vanadium ore is being carried on. The Yellow Pine Extension shipped a car of zinc ore last week. Big things are expected of this neighbor of the Yellow Pine, the largest producer of zinc and lead in Nevada.

Frank J. O'Kelly reports that the Frederickson group has been able to increase its output of concentrate by fifty tons per month on account of recent improvements.

R. J. Goodwin, of the Boss mine, has been advised that a large party of Minneapolis capitalists interested in several mines of the district, will make a trip to the district at an early date. It is safe to say that no small mine in America has attracted so much interest from mineralogists and rare-mineral experts as has the Boss. A recent rush shipment of high-grade ore from this mine to the Pacific Platinum Works in Los Angeles assayed 49 oz. gold and 85 oz. combined platinum and palladium. This ore is the plumbo-jarosite, which, according to Adolph Knopf, of the Geological Survey, carries the rare metals.

Goodsprings, May 11.

NEW MEXICO

Luna County

(Special Correspondence.)—P. R. Smith, of Deming, and associates, who have incorporated a company with a capital stock of $1,500,000 to operate the Sanduval Consolidated Copper mines near here, will install a 150-ton flotation concentrating plant and a 35-ton smelter.

The Gymkana Mining Co., of Columbus, will install a concentrating-plant to handle the ore from its mine in the North Peak district.——The Kentucky Mining Development Co. is being organized at Columbus to take over and operate the Kentucky mines situated near that place. Power drilling-equipment and mill will be installed.

Deming, May 14.

Socorro County

(Special Correspondence.)—The Socorro Mining & Milling Co.'s output for last half of April was 1900 lb. gold-silver bullion, making a total for the month in excess of 1¾ tons. About 200 tons of ore is treated daily.

The bullion output of Mogollon Mines Co. for same period was 1600 lb., a total of over 1½ tons during April. In addition to the bullion, this company makes regular shipments of concentrate to smelters.

The Oaks Company made another shipment of ore to a custom-mill from the Eberle mine the past week, from development work only. At the Maud S. property the company is now breaking ore in three different places and is sending it to a custom-mill daily, packing the ore by burro-trains.

As the snow is now about off the divide the Mogollon sawmill is preparing to start for the season and lumber deliveries will begin in a few days.

Mogollon, May 14.

Taos County

(Special Correspondence.)—The Buffalo New Mexico Co. is working three shifts in its adit on Pioneer creek. Sixteen men are employed. Richard Kelly is superintendent. Mr. Yunker, of Buffalo, New York, has returned to the East after an inspection of the property.——The Memphis Red River Mining Co. is operating its new oil-flotation mill on Red river, just below town, with satisfactory results. The machinery is operated by water-power.

The Chief Consolidated is driving a development adit on its claims on Goose creek. A large flow of water has been struck.

The El Moro M. & M. Co. is freighting in machinery from Ute Park for an amalgamation and concentration-mill for its property at Anchor, six miles from Red River.

At the property of the Caribel M. & M. Co. the Caribel vein was cut last week 100 ft. above the adit-level. A 60-ft. raise will connect with the upper workings. The vein where cut is of good width and value. The force at this mine will be increased as fast as men are available. There is a marked scarcity of hand-miners here. All work in this camp is being done by hand-drilling, although some of the properties will install machines this year.

Red River, May 12.

OREGON

Jackson County

(Special Correspondence.)—H. H. Leonard, who arrived here from Coeur d'Alene last season, is operating the Bowden claims, four miles east of Gold Hill. The mine is owned by J. F. Davis, a local miner, and is situated on the south-east slope of Blackwell hill, near the Pacific highway. Early the present year two mill-tests were made by Leonard from the upper available stopes; 9 tons averaged $7 in gold per ton, and 16 tons averaged $8.60 in gold per ton. The ore from this vein has all been free-milling, running from $7 to $300 per ton; the concentrate from the two tests referred to assayed $160 per ton. This vein was first discovered and worked by two ranchers, James McDonough and James Davis, who recovered $10,000 from $300 ore from a depth of 50 ft. Since it was first operated the vein has produced about $30,000, though always mined in a crude manner. The vein is in tonalite, strikes N. 75° E., and dips 85° N. It is from 8 to 30 in. wide, in a 500-ft. drift at a depth of 120 ft. The main shaft west of the original works is 185 ft. deep on the vein, and the 500-ft. drift extends from this shaft. The present lessee has installed steam-power pumps, and hoist, and re-opened the 120-ft. level. He is preparing to join the 120-ft. level west of the main shaft with the other works, and is already down 40 ft. on the new shaft; 30 ft. more will reach the 120-ft. level. A pump with a 2-in. suction readily handles all the water.

Gold Hill, May 14.

(Special Correspondence.)—H. H. McCarthy, an old time mine operator in this district, recently took an option on the North Pole-Lucky Boy group of quartz mines, situated eight miles west of Gold Hill, and south of Rogue river within a mile of the stream. It is owned by Phil Robinson and others living in the district, who discovered the vein six years ago. The lessee is erecting a ball-mill of 15-ton capacity on the property. The mill will be operated by electric-power, which will be available in a short time. A small force of miners is employed in developing for an extensive run on the

ore as soon as the milling equipment is completed. The owners last year shipped three carloads of the ore to the Selby smelter and had five carloads milled at the Opp mill in this valley. All this ore averaged $28 per ton in gold. The vein strikes due east and dips north at 45°. The vein is from 14 in. to 4 ft. wide. The hanging wall is andesite and the foot-wall is slate. The ore is oxidized near the surface, but at a depth of 50 ft. merges into the base ore. The strike extends up a steep hill sloping toward the river at an angle of 45° with an elevation of 900 ft. at the base, and 2100 ft. at the apex. The principal works on the property is a drift of 175 ft. on the vein at an elevation of 1800 ft., and a drift of 140 ft. on the vein about 1000 ft. below the apex of the hill.

Gold Hill, May 16.

UTAH

Elaborate plans for expansion have been made for the Utah Copper Co. and the other Jackling porphyries as a result of which by mid-year the combined output of the Utah, Ray Consolidated, Chino, and Nevada Consolidated companies should reach a rate of 500,000,000 lb. of copper per annum.

Eventually the two Utah plants will have capacity for handling 50,000 tons of ore per day with the ultimate object of producing 30,000,000 lb. of copper per month.

Ray Consolidated put through its mill last month approximately 10,000 tons of ore daily. This resulted in a March production of more than 8,000,000 lb., a record for any month. This figure should be maintained with ease.

Chino is expected also to produce close to 100,000,000 lb. per year. Its seven-section mill will be able to treat 12,500 tons of ore daily, representing a 40% increase over the present five-section plant. This will not be before the end of the year, however, as the second of two new units cannot be finished for some months, owing to delays in delivery of machinery.

The Nevada Consolidated plant is also being enlarged, but this work will not be completed for several months.

Salt Lake County

(Special Correspondence.)—James E. Higgins is working a lease on the property of the Fortuna Mining & Milling Co. at Bingham. The property is owned by Governor Bamberger, and consists of 170 acres and adjoins the Ohio and Utah Copper on the south-east and east. The property has been idle for many years. Since obtaining the lease and option on this property the lessees have shipped 77 cars of high-grade copper ore, and have developed many thousands of tons of low-grade ore. They are now preparing to install a 'K & K' oil-flotation machine of about 100 tons capacity. Recent tests show that a direct saving of from 87 to 96% will be made by oil-flotation. In the mill the operation will be as follows: crush to 65-mesh in a 6-ft. by 16-in. Hardinge ball-mill, the pulp going direct to a K & K machine, using no tables. The ore consists of veinlets of chalcocite in quartzite. The principal vein is known as the Mayflower and is about 35 ft. wide. The average copper content is 1½ to 2½%. Recently 700 tons was shipped to the Garfield plant and the average content was 3.6% copper, 6.5% iron, and 80% silica. The veins all dip under Bingham canyon and therefore under the Utah Copper property. Some interesting developments are expected soon, when the Mayflower and Fortuna veins are opened up at a depth about 1400 ft. deeper than any of the present workings. This will be accomplished through the transportation and drainage adit of the Montana Bingham Consolidated Co. This adit is in 4800 ft. and in the next 300 ft. the Mayflower vein should be cut.

It is not improbable that this development work, after driving on the vein, will open up several million tons of ore, and from present indications another large milling property will be opened in this district. In the testing, as high as 96% of the copper has been floated, the iron dropping with the silica, so that most of the iron will go into the tailing and may be recovered later if advisable.

Bingham, May 13.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

T. A. Rickard is in Colorado.

L. B. Newby has gone to Oregon.

Jules Labarthe is at Kellogg, Idaho.

Charles Butters is leaving for Chile.

Ernest G. Locke is at the Clift hotel.

E. H. Nutter has returned from Butte.

W. G. Swart is in New York from Duluth.

F. W. Bradley has gone to Kellogg, Idaho.

J. H. Mackenzie has returned from Alaska.

Frank L. Sizer is at Sutter Creek, California.

Louis Gooding was here from Melones, California.

Kirby Thomas has returned to New York from Brazil.

B. L. Thane has gone to Vancouver, British Columbia.

Walter H. Aldrich will be in San Francisco about June 1.

C. T. Griswold is in Oklahoma, engaged in geological work.

Nelson Dickerman has returned from New York and Boston.

H. N. Thomson has left the United Verde company and is in Los Angeles.

J. E. Rasmusen was in San Francisco and has gone to Plumas county.

H. E. Bush is in San Francisco from Taylorsville, Plumas county, California.

J. M. Hyde is not expected to return from Butte before the latter part of June.

George Otis Smith has been appointed a member of the National Research Council.

Mark R. Lamb has returned to New York after several years spent in South America.

G. Howell Clevenger has been appointed research professor of metallurgy at Stanford.

O. E. Roodhouse, superintendent of the United States Tungsten Corporation of Ely, Nevada, is in San Francisco.

Fred H. Kay has resigned as Assistant State Geologist of Illinois to become associated with the Sun Company, of Philadelphia.

V. H. McNutt has gone from Tulsa, Oklahoma, to Lexington, Kentucky, to investigate the petroleum possibilities of Kentucky.

C. G. Visel has resigned the superintendency of the Mile Wide Copper Co.'s property and has no further connection with that concern.

A. E. Drucker and G. W. Laurie have opened an office at 30 Church street, New York. The firm will be known as Drucker & Laurie.

Fred B. Ely, M. S. Lindholm, and R. C. M. Page, mining engineers, are attending the Officers' Reserve Corps training camp at the Presidio.

Charles H. Lee, of Los Angeles, has been assigned to duty as an engineer officer of the Officers' Reserve Corps. During his absence his practice will be directed by W. K. Bernard.

Victor C. Alderson, John M. Baker, and Hamilton W. Baker have associated themselves as the firm of Alderson, Baker & Baker, at 185 Devonshire street, Boston, with a branch office at Boise, Idaho.

Obituary

C. D. Fraser, treasurer of the Old Eureka Mining Company, and also treasurer of the Hedley Gold Mines Co. of British Columbia, died at his home in New York on May 7.

Edgar Smart, who is known throughout the metallurgical world as one of the authors of the work on cyaniding gold ores, in which he collaborated with H. Forbes Julian, was murdered by natives in East Africa, in December.

THE METAL MARKET

METAL PRICES

San Francisco, May 22

Antimony, cents per pound	23
Electrolytic copper, cents per pound	33
Pig lead, cents per pound	10.25—11.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb.	$95
Spelter, cents per pound	..
Tin, cents per pound	..
Zinc-dust, cents per pound	20

For several months past we have published weekly herein the San Francisco market quotations on lead, copper, zinc, and tin, together with some others. Now, however, owing to the unsettled condition of the market and consequent difficulties in obtaining the prices on the four metals above mentioned, we refer those interested to the New York quotations, which we receive by wire each week and which are accurate.

ORE PRICES

San Francisco, May 22

Antimony, 50% metal, per unit	$1.65
Chrome, 40% and over, f.o.b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tungsten, 60% WO_3, per unit	20.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 45% (under 35% metal not desired), cents, unit.	36—38

Manganese prices and specifications, as per the quotations of the Carnegie Steel Co. schedule of prices per ton of 2240 lb. for domestic manganese ore delivered, freight prepaid, at Pittsburg, Pa., or Chicago, Ill. For ore containing

	Per unit
Above 49% metallic manganese	$1.00
46 to 49% metallic manganese	0.98
43 to 46% metallic manganese	0.95
40 to 43% metallic manganese	0.90

Prices are based on ore containing not more than 8% silica nor more than 0.2% phosphorus, and are subject to deductions as follows: (1) for each 1% in excess of 8% silica, a deduction of 15c. per ton, fractions in proportion; (2) for each 0.02% in excess of 0.2% phosphorus, a deduction of 2c. per unit of manganese per ton, fractions in proportion; (3) ore containing less than 40% manganese, or more than 12% silica, or 0.225% phosphorus, subject to acceptance or refusal at buyer's option; settlements based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken to be deducted from the weight. Prices are subject to change without notice unless specially agreed upon.

Manganese: The demand for manganese in the East continues strong and the schedule prices remain at $1 per unit or under; 40% has always found ready buyers at comparatively good prices and the market has a very firm tendency. Chemical ore is quoted at 4½ to 6c. per lb, according to grade.

Tungsten: The tungsten market at New York developed further strength during the past week and absorbed all of the ore of desirable quality. The demand for prompt delivery forced the buyers, for the first time, to accept schedule prices and business has been done repeatedly during the past week at a $20 basis for 60%, $21.50 for 65%, with other grades in proportion. There is quite a large demand at the moment of writing, for spot delivery and it has become necessary, in order to meet a 50-ton inquiry, to make up the 50 tons from several small lots. Arrivals from South America expected during this week have been contracted for already with the exception of small quantities and the unsold ore is offered at schedule prices.

EASTERN METAL MARKET

(By wire from New York)

May 22.—Copper is inactive but firm, with prices nominal at 32.50c. Lead is strong at 10.50c. Zinc remains steady and quiet at 9.37c. Platinum is unchanged at $105 for the soft and $110 for hard.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
May 16	74.87	Apr. 10	73.72
" 17	74.87	" 17	73.27
" 18	74.87	" 24	74.08
" 19	74.62	May 1	74.06
" 20 Sunday		" 8	74.92
" 21	74.87	" 15	74.69
" 22	74.62	" 22	74.78

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.55	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	72.51	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	55.04	....	Dec.	55.34	75.70	....

The circular letter of Samuel Montagu & Co. of April 26 contains the following concerning silver:

The market has shown considerable steadiness at a somewhat higher level. The outstanding feature continues to be the scantiness of the supply, rather than a pressure to buy. The Shanghai exchange has risen in sympathy with the price of silver and sales from that quarter are not reported. Although reports show that there is likely to be an increased activity in the mining industry of Mexico, it does not follow that much silver will come on offer from that country. The details as to Mexican coinage suggest that considerable demands will be made for that purpose upon the local output.

The Indian currency figures recorded below in lacs of rupees show a reduction of 45 lacs in the treasury holding. This is the third successive week that the total has shrunk and is the lowest since February 7 last.

	April 7	April 15	April 23
Notes in circulation	8410	8447	8340
Reserve in silver coin and bullion	1736	1674	1629
Gold coin and bullion in India	1158	1219	1156
Gold in England	667	592	592

The stock in Bombay consists of 1500 bars, as compared with 1700 bars last week.

The stock in Shanghai on April 21 consisted of about 26,500,000 oz. in sycee and $17,200,000, as compared with about 28,000,000 oz. in sycee and $16,400,000 on April 14.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
May 16	32.00	Apr. 10	33.83
" 17	32.00	" 17	32.75
" 18	32.25	" 24	31.47
" 19	32.25	May 1	30.43
" 20 Sunday		" 8	31.37
" 21	32.50	" 15	32.00
" 22	32.50	" 22	32.25

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	33.16	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
May 16	10.50	Apr. 10	9.35
" 17	10.50	" 17	9.35
" 18	10.50	" 24	9.43
" 19	10.50	May 1	9.62
" 20 Sunday		" 8	9.93
" 21	10.50	" 15	10.49
" 22	10.50	" 22	10.50

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	9.38	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound

Date		Average week ending	
May 16	9.37	Apr. 10	10.64
" 17	9.37	" 17	9.87
" 18	9.37	" 24	9.58
" 19	9.37	May 1	9.23
" 20 Sunday		" 8	9.61
" 21	9.37	" 15	9.37
" 22	9.37	" 22	9.37

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.90	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	10.20	Oct.	14.05	9.92	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
Date		May 8	113.00
Apr. 24	113.00	" 15	106.00
May 1	113.00	" 22	95.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.00	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	114.50	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

A very noticeable drop in the price of quicksilver has taken place during the week, from $106 to $95. The market is unsettled, and no safe prediction can be made as to the price even in the immediate future.

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	48.25	51.49	55.63	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Tin is abnormally high, the New York quotation being at present around 65c. It was as high as 66.50c. on May 16, going up steadily from 58.50c. at the beginning of the month.

Platinum is quoted at $105 for soft unalloyed metal and $110 for the hard natural platinum-iridium alloy.

Molybdenite: There is very little business reported in molybdenite, and prices remain unchanged.

Antimony ore: After a long interval, business has again been done in South American antimony ore at $2.30 per unit and short ton.

Eastern Metal Market

New York, May 16.

All the metals are decidedly firm, with some much stronger than others. There has been active buying of three of the group, with a dull but firm tendency in the other two.

Copper, while rather dull and inactive, has a firm tendency.

Zinc has remained quiet, but is regarded by no means weak but firm.

Lead is scarce and strong in a fairly active market, good sales being reported.

Tin has had a sensational advance and is higher than in many weeks.

Antimony experienced a decline in the last week, but is again higher and strong.

In the steel market prices continue to soar. Tin-plates have gone at record prices and ship-plates are still without limit, as high as 10.40c. being paid on 1000 tons of hull-plates for Canada. The Government's needs are not yet definite and producers await developments as patiently as possible. It is plain now that the buying of war steel, copper, and other metals, by the Government and the Allies will be done jointly.

COPPER

Not much activity is reported, though some business has been done in third-quarter metal and a little in spot and nearby. In the latter position quotations are conflicting, the metal being scarce this side of July. It is probable that sales of small lots have been made at 31.50 to 32.50c., New York, in the past week. The quotation for early delivery is generally regarded, taking the average of several quotations, as 32c., New York, for both electrolytic and Lake, but it is normal. For third quarter 28.50 to 29.50c. is asked, and business has been reported done at these prices. Some quote 27 to 28c. for the fourth quarter. The market is dull but strong. The underlying strength is due to the belief that consumption is bound to be large for many months to come, especially the needs of the Government and the Allies. Some report that quiet buying is now going on by the Government, while others express skepticism as to this. It is believed, however, that whatever these war needs are and whenever they are bought. they will go at 25 to 27c., New York. The London market was quiet and unchanged yesterday at £142 for spot electrolytic.

TIN

This market has experienced a sensational rise since last week. The metal has advanced almost daily since the last report. Early-delivery tin was selling May 8 at 59.37½c., New York, but on May 9 it advanced to 63c., on May 10 and 11 to 64c., on May 14 to 65c. and was selling yesterday at 65.75c., New York, an advance of over 6c. per lb. in a week. One important cause for this upward movement was the Government proposition of an import tax of 10% on all non-dutiable imports, of course including tin. While indications today are that a revision of this proposed tax will be made before it is a law, the trade will not be surprised if some tax is levied. Another important factor in the advance is the strength of the London market, where the metal in the last week has advanced £21 per ton or from £232 12s.6d. a week ago to £253 yesterday. Nothing definite is known here as to the cause for this unusual rise. Some conjecture that it is due to sunken tin-cargoes while others think that ships may have been withdrawn from the Atlantic service. Early this week, after a few days of comparatively little buying, inquires for about 150 tons of spot and nearby metal appeared which on Monday resulted in sales of perhaps half of this. Some business was also done in tin afloat and for early shipment from London. Yesterday, with less inquiry, heavy sales were reported, totaling 150 to 200 tons, mostly for nearby delivery. Imports of tin at Pacific points in March are reported at 665,187 lb. at San Francisco and 1,618,079 lb. in Washington. Arrivals in this month to May 15 have been 2680 tons, with the quantity afloat 3597 tons.

LEAD

The statement last week of the *Engineering and Mining Journal* that the Government's requirements for May-June delivery were only 2500 tons tended to release some supplies withheld from the market. As a consequence the metal was not quite as scarce, and a fairly active market developed with good sales recorded. Business in fact was widespread. Late last week May metal sold at 10.25c., St. Louis, with June offered at 10.12½c., St. Louis. Sales in the East were recorded at 10.45 and 10.50c., New York. Most of the cheap lots were wiped out. The quotation yesterday for early delivery was 10.50c., New York. One dealer reports the sale of a carload of lead for delivery as early as possible at 11.62½c., New York. The market is very strong, due to the belief that when the Government's needs are known or satisfied there will not be enough lead to go round.

ZINC

The active market which was expected to follow the announcement last week of the Government purchases of over 10,000 tons of zinc has not materialized. It now develops that only 225 tons of grade C, or prime Western spelter, was included in the purchase, the rest of the amount bought including 6704½ tons of grade A and 3440½ tons of grade B instead. Naturally so small a tonnage of the lower or regular spelter could have but little, if any effect, on the market and the past week has been characterized by little active demand. Sales have been made at the ruling quotations but only for May-June delivery, producers declining to commit themselves as to futures to any extent in so uncertain a market. The market, however, is generally firm and steady, the decision as to Government prices, and the fact that more is yet to be bought, inducing a firm tone. Quotations, at which sales have been made almost daily the past week, are 9.12½ to 9.25c., East St. Louis, or 9.37½ to 9.50c., New York, for May-June delivery. Some quote 9.12½c., St. Louis, for July metal. The attitude of both buyers and sellers is generally a waiting one.

ANTIMONY

The market experienced a further decline since our last report, and metal for early delivery sold at one time as low as 22c., New York, duty paid, due to further arrivals. Since then it has risen again owing to stocks falling into the hands of stronger parties, and the quotation is now 26 to 26.50c. Interest in futures is very strong, May shipment being quoted at 17.50c. in bond and June and July at 16 cents.

ALUMINUM

Buyers and sellers are few and the market is unchanged at 59 to 61c., New York, for No. 1 virgin metal, 98 to 99% pure. The recent export-inquiries are reported to have resulted in no sales. The market is, however, steady but dull.

ORES

TUNGSTEN. Some brokers report no sales of concentrates on the basis of new quotations of $20 per unit for 60% ore, while others say that the demand has been so strong the past week that business has been done at $20. Undoubtedly demand is good, and expected arrivals from South America have been contracted for already, according to reports. Ferro-tungsten is unchanged at $2 to $2.15 per lb. of contained tungsten.

ANTIMONY. Ore from South America is reported sold at $2.30 per unit, which is the first business done in a long time, according to the brokers.

Company Reports

MOTHER LODE COPPER MINES COMPANY

The annual report for the year ended December 31, 1916, follows:

During the year the mine was operated 360 days and closed down 5 days—Fourth of July 3 days; Thanksgiving, 1 day; and Christmas, 1 day. Total of 8-hour shifts, as per time-book, 84,904. Average number of men, 28.

MINE DEVELOPMENT AT THE END OF THE YEAR

	Feet
Open-cuts	143
Cross-cuts	1119
Drifts	4272
Raises	1342
Inclines	700
Winzes	179
2-compartment shaft	51
Total	7806

Making the total cutting for the year was 2765 ft., all of which was done by hand-drilling, and showed a gain of 288 ft. over the previous year when power-drills were operated for 38 days.

ORE RESERVES IN SIGHT AND ESTIMATED

	Ore, tons	Copper, %	Silver, oz.	Tons of copper	Ounces of silver
Ore on surface, broken in stopes, and intact above Marvelous level	31,368	15	4	4,705	125,472
Ore between Marvelous level and Pittsburgh level	43,632	15	4	6,544	174,528
Ore between Marvelous level and Pittsburgh level	5,115	30	8	1,534	40,920
Ore between Marvelous level and Pittsburgh level	3,000	60	15	1,800	45,000
Ore between Pittsburgh level and bottom of incline 100 ft	9,864	15	4	1,479	39,456
Ore on dumps	21,349	8	2	1,708	42,698
	114,328			17,770	468,074

In addition to the above, there is at the lower tramway-terminal, McCarthy railroad depot, and afloat, the following tonnage of ore with its estimated value:

Ore, tons	Copper, %	Silver, oz.	Tons of copper	Ounces of silver
450	60	15	270	6,750
585	30	8	175½	4,680

Copper value at 30c. per lb	$267,300.00
Silver value at 75c. per oz	8,572.50
Total value	$275,872.50

ALASAKA GOLD MINES COMPANY

The fifth annual report of the Alaska Gold Mines Co. for the year ended December 31, 1916, shows the following:

Tons milled	1,892,788
Gross value per ton	$1.193
Yield	0.970
Tailing	0.222
Extraction, per cent	81.33
Milling cost per ton	$0.269
Value recovered	0.970
Operating expenses less miscellaneous income	0.732
Total profit per ton	$0.238

The report of the president says, regarding the above statement: While the foregoing figures show that the business was operated for the year 1916 at a profit, it goes without saying that the results are exceedingly disappointing. At the time this enterprise was presented to the public it was confidently expected that there would be a profit of approximately 75 cents per ton of ore handled. This profit was estimated on working-cost of 75 cents per ton, and on recovered values of about $1.50 per ton. The original estimates were based on mill records of an experimental plant operated prior to the acquisition of the property by the company, and the most thorough examination of which such a body of ore is susceptible before its actual mining. The recovered value has been much less per ton than was expected, at the same time the working expenses have fully met the original estimates, despite the large increases in the cost of materials and labor, due to current conditions.

ANACONDA COPPER MINING COMPANY

The annual report of the Anaconda Copper Mining Co. for the year ended December 31, 1906, follows:

During the year the company augmented its holdings by several important purchases. These included the Pilot Butte mine for which $1,125,000 cash was paid. The east part of the Alex Scott claim was bought for $750,000.

In addition to these the outstanding interests in the Robert Emmet No. 1, and the Robert Emmet No. 2 claims, lying next of the Gagnon-Original group, were purchased for $30,598.31. The Raven mining claim was bought for $63,359.25, and other property in Butte district was acquired at a cost of $16,231.35.

PROFIT AND LOSS ACCOUNT

Metals in process and on hand at beginning—copper and lead at cost; silver and gold at market	$18,944,074.67
Mining expenses, including development	24,709,070.58
Ore purchases, including transportation	15,227,457.63
Reduction expenses, including transportation	19,183,022.68
Refining, selling, and transportation	6,760,479.68
Cost of merchandise sold	5,210,178.13
Administration expenses and taxes on income and on timber lands	1,613,424.35
Balance carried down	56,542,338.65
	$148,190,046.37
Amount charged off this year for depreciation and obsolescence of mining plants, smelters, refineries, etc.	$7,113,463.00
Interest	951,144.91
Balance, being profit, carried to foregoing balance sheet	50,828,372.29
	$58,892,980.20
Sales of copper, lead, silver, and gold—that is, deliveries to customers	$96,097,709.01
Sales of merchandise	7,191,365.94
Royalties, tolls, rentals, etc.	7,675,167.40
Metals in process and on hand at end—in process, at cost; on hand, sold, at contract prices	37,225,804.02
	$148,190,046.37

Mining Decisions

Mining Partnership—Rule Not Applicable

A partnership engaged in exploring prospective oil territory is not a "mining partnership," which is defined by California law as existing when two or more who own a mining claim for purposes of working it and extracting the mineral therefrom actually engage in working it, but is a partnership of general scope.

Callahan *v.* Danzizer (California), 163 Pacific, 65. December 27, 1916.

Oil Land Withdrawal—Burden of Proof

A withdrawal of land for inclusion in a petroleum reserve based upon an examination and report of its mineral character, establishes prima facie its character as mineral and one seeking thereafter to have it classified as non-mineral assumes the burden of proof to overcome such prima facie established mineral character.

Henry Hildreth (Land Department), 45 Land Decisions, 464. August 31, 1916.

Mining Easement—Held Appurtenant

A grant of the right to extract coal and other minerals, together with an easement for the construction and operation of a railroad over which to haul minerals and timber from the land in question, and from other land owned by the grantee, is a grant of an appurtenant easement in the land, and subsequent grantees of the property take it subject to such easement, even though part of the minerals hauled comes from other lands and part of the timber is sold instead of used in the grantee's mining operations.

Jones *v.* Island Creek Coal Co., (West Virginia), 91 Southeastern, 389. February 6, 1917.

Alaska Coal Lands—Consolidated Locations

The provision in the Act of May 28, 1908, authorizing the consolidation of coal land locations in the territory of Alaska under certain circumstances, contemplates only such valid and complete locations as had been in good faith made and maintained in accordance with the provisions of the prior existing law of April 28, 1904; and does not operate to validate or cure prior locations which were defective or invalid because of failure to open or improve mines, erect monuments, or to prepare and file notice of location as required by the law in force at that time. Work done merely for prospecting purposes and not with the purpose or design of actually mining and producing coal does not meet the requirements of the statute and does not serve as a basis for a valid location.

Alaska Petroleum & Coal Co. (Land Department), 45 Land Decisions, 56. April 26, 1916.

Mining Lease—Verbal Surrender

No one will be permitted to acquire and hold mining leases without development where the payment of a royalty upon the ore produced is provided for in the lease. Although it might be conceded that the owner of a mining lease could not assign his rights to a stranger except by an assignment in writing, be could verbally surrender the leasehold to the lessor. If the former partner of such owner, who was required by his contract to give his full time to developing the property, left the State for a number of years and did not communicate with the other partner, his acts constituted a complete abandonment of the partnership, and the remaining partner had the right to surrender the lease without being at all accountable to the former partner.

United Mining Company *v.* Morton (Kentucky) 192 Southwestern, 79. March 2, 1917.

Recent Publications

Report on the Price of Gasoline in 1915 by the Federal Trade Commission. Pp. 223 with map and numerous graphic charts. Washington 1917.

In accordance with certain Senate resolutions the Federal Trade Commission is conducting an investigation of the petroleum industry in all its phases. During the latter part of the year 1915 numerous complaints from all parts of the country came to the Commission, charging that the price of gasoline was unreasonably high, and that gross discriminations in price were being practised by refiners and others. These complaints were of such a character and so numerous that the Commission deemed it in the public interest to make a special investigation. This report is the result of that inquiry.

During the year 1915 there were marked changes in the price of gasoline, a fall in prices in the early part of the year being followed by an extraordinary advance. Though varying in different sections of the country, this advance may be roughly dated from July. Taking the wholesale (tank wagon) price as representative, the amount of the advance during the second half of the year was generally between 7 and 9c. per gallon, a rise of from 75 to 85%. In some parts of the country it was more than this; in others less. The advance in retail prices was similar in amount. If the contemporaneous decline in quality of gasoline is considered, the true advance is still greater.

The Fourteenth Biennial Report of the Bureau of Mines, of Colorado, for the Year 1915-'16. By Fred Carroll, Commissioner. Pp. 116, with maps.

This excellent volume, though small, is concise and filled with valuable information concerning the mineral resources of the State, describing briefly the important mines and mineral deposits in each county. In a pocket at the back of the book are a number of maps of individual counties, which are useful to all who are interested, and it is hoped that similar maps of the other mineral counties of the State will be issued later.

Useful Minerals in the United States. Compiled by Frank C. Schrader, Ralph W. Stone, and Samuel Sanford. Bulletin No. 624 of the United States Geological Survey. Pp. 412. Being a compilation of the mineral resources of the several States, alphabetically arranged, so that the reader may quickly find the information desired concerning the occurrence of any mineral in any State in the Union. This is a revision of Bulletin No. 585, which is now out of print.

Seventeenth Biennial Report of the State Bureau of Labor Statistics of California. By John P. McLaughlin, Commissioner, San Francisco. State Printing Office, Sacramento, 1916. Pp. 386.

The volume consists principally of tabulated statements, regarding the labor conditions in California during 1915-16.

Asphyxiation from Blast-Furnace Gas. By Frederick H. Wilcox. Technical paper No. 106, of the United States Bureau of Mines. Ill. with half-tones and line-drawings. Pp. 69. Washington, 1916.

The Resources of Tennessee. A quarterly review of the conservation and development of the resources of Tennessee. Issued by the State Geological Survey. Nashville, 1917. Pp. 108. Illustrated.

Oil Resources of Black Shales of the Eastern United States. By George H. Ashley. Bulletin No. 641-L, being a part of Contributions to Economic Geology for 1916. Part II. Pp. 22.

INDUSTRIAL PROGRESS

A Leyner Sharpener for Small-Size Drill-Steel

Machine-sharpened drill-steel has conclusively demonstrated that, due to consistent bit perfection, the time of actual drilling has been cut and the strain and wear on drilling-machines reduced. That these benefits have been restricted to the use of a considerable number of drills, has been due to the relatively large investment for a drill-sharpener as compared with the volume of work. Now comes a new sharpener of such size as to make its use worth while to users of even two or three drills.

The Ingersoll-Rand Co. has placed on the market the Leyner jacksteel sharpener, a small edition with modifications, of the

SMALL LEYNER DRILL-SHARPENER

standard No. 5 Leyner sharpener. The new machine is designed to handle the small sizes of steel such as are used with jackhammers, stopehammers, plug-drills of various kinds, and the like. The manufacturer limits its capacity as follows:

Steel-sizes: 1⅛-in. maximum diameter round, cruciform, and light section, twisted or banded-steel; 1-in. maximum diameter hexagon or octagon-steel; ⅞-in. maximum diameter square-steel.

Bit sizes: 2-in. maximum diameter, 4, 5, 6-point, Z, X, and single or double chisel-bits of standard 14° taper; 1⅝-in. maximum diameter 'Carr,' or bits of other than 14° taper. Shanks can also be made on the smaller sizes of steel by the usual Leyner method.

As the illustration shows, the Leyner jacksteel sharpener is of simplified design and extremely compact. Its weight is 925 lb., which permits ready transportation when desired. No foundation is required other than a planking support about 3½ ft. square.

An unusual feature is the employment of a single piston-rod on the clamping-piston. This allows the Leyner die and dollying-hammer to be so placed as to operate immediately under the eye of the operator. This advantage of complete visibility of the entire operation is stated to be of prime importance in securing the best possible grade of work. An entirely enclosing die is employed, as with the large Leyner sharpener, in which the metal of the bit is thoroughly compacted by the dollying-hammer. The completion of the sharpening operation within the die effects the same absolute correctness of gauge, and exact duplication of bits of any gauge. A single lever (under the operator's hand in the cut) controls both clamping and dollying. This, it is claimed, conserves the muscular efforts as well as the time of the operator.

The Leyner jacksteel is 4 ft. high, 3 ft. long, and 2 ft. 4 in. wide; it operates by compressed air.

The Ingersoll-Rand Co. has published a 6 by 9-in. bulletin, No. 4037, describing this machine.

The Lunkenheimer Company's New Ferrous Foundry Building

The growth in the business of the Lunkenheimer Company, of Cincinnati, Ohio, has necessitated the erection of a more commodious building for the casting of products made of ferrous materials. The new foundry occupies an area of 36,000 sq. ft., and the pattern-storage building an area of 18,000 sq. ft., the latter building being four stories in height.

Both the pattern-storage and foundry buildings are of reinforced concrete. Provision has been made to add two more floors to the pattern-storage building, and the wall at one end of the foundry is so built as to enable easy removal to extend this building when more space is required. Excellent light and ventilation is afforded by the saw-tooth roof-construction of the foundry, together with the large number of Fenestra windows used. Great precaution has been taken to guard against fire, a sprinkler-system having been installed, and wherever possible fire-proof material is used throughout the buildings. The floor of the foundry building is of creosoted wood-block which makes an excellent smooth surface, exceptionally durable and easily repaired.

A wash-room for employees adjoins the foundry and is kept scrupulously clean, due to the constant care given by janitors. Shower-baths are provided for employees and each has his own steel-locker for clothes.

For the melting of iron, a cupola having a capacity of 10 tons per hour is used. The molten metal is poured from the cupola into large crucibles mounted on wheels, which are easily pulled on rails to destination. These crucibles can be tilted in order to fill the small ladles used in pouring the metal in the molds. Compositions of other ferrous materials are melted in revolving furnaces of Lunkenheimer design, these furnaces being particularly adapted for the special treatment used in Lunkenheimer products.

Six traveling cranes, the majority of which are electrically operated, are provided for handling the heavy work, and every department or appliance necessary for the efficient operation of an up-to-date foundry are present and arranged in systematic relation to each other. Directly in the rear of the Lunkenheimer foundry is a railroad from which a spur is run

to a concrete storage-house. All the sand, coke, and other materials needed is obtained and delivered with the least possible handling.

The rush of business made it imperative that all machinery be moved from the old foundry building to the new, a distance of about a city block, in the shortest possible time. That no time was lost is evidenced by the photographic reproductions

FIG. 1. THE VACANT FLOOR

FIG. 2. FLOOR FILLED WITH MATERIAL

shown in Fig. 1 and 2, the former view having been taken Saturday noon, March 24, and shows the building practically empty, and the latter view taken Monday morning, March 26, shows the great quantity of material which had been moved during this short period and which enabled many molders to continue their work without loss of time.

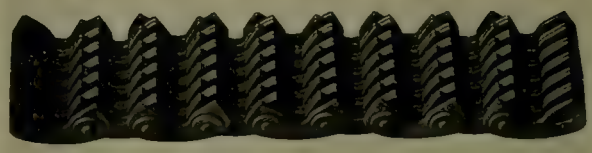
The foundry for making non-ferrous castings, such as bronze, brass, aluminum, nickel, etc., compositions, is in another building.

The TRAYLOR ENGINEERING & MANUFACTURING CO., of Allentown, Pennsylvania, has issued an interesting booklet, (Bulletin R-1) on crushing-rolls. It contains 36 pages of handsomely illustrated text, showing the various types of rolls made by that firm. The pamphlet contains some sensible suggestions on the practical operation of rolls in crushing ores and there are several useful and instructive graphic diagrams, illustrating the capacity of Traylor rolls of various size. One of the best tables in the book is that giving the proper space between rolls when ore is to be crushed to a stated mesh.

Silent Chain-Drive Power-Transmission

Silent chain for production and auxiliary machinery-drives in mines, mills, and smelters is meeting with increased favor as its merits become better known. Link-belt silent chain drives are 98.2% efficient, on actual test, whether operating on

LINK-BELT SILENT CHAIN



LINK-BELT SILENT CHAIN
Showing the teeth of the chain, which mesh into the teeth of the wheels

long or short centres, in hot, cold, damp, and oily places. Silent chain-drives make possible more convenient application of motors, as they save floor-space, do not require the fixed centres of gear-drives, and permit a better arrangement of individual machines. The short centres make it possible to encase the drive in accordance with 'Safety First' practice, and at the same time permit the drive to operate in a bath of oil.

LINK-BELT SILENT CHAIN–DRIVE

PATENTED PIN–BUSHED–JOINT OF LINK–BELT SILENT CHAIN

Link-Belt silent chain consists of a series of leaves or plates, the joints of which comprise two segmental case-hardened liners or bushings, and a case-hardened steel-pin. The best grades of steel for the various parts of the chain, and the proper relative hardening and heat-treating, have been determined by carefully conducted experiments, supplemented by extensive practical experience. The utmost care is exercised in the manufacture of Link-Belt silent chain to secure uniformity and accuracy of the chain parts.

The success of Link-Belt silent chain is due to the superiority of its joint construction. The segmental liners, or bushings, shown in the illustration, are removable, and extend across the entire width of the chain, thus doubling the bearing-surface, and halving the bearing-pressure on the joint. As a result, the pin wears uniformly, keeps round, and the chain maintains to the end its high initial efficiency.

The Link-Belt Company, of Chicago, and 461 Market street, San Francisco, have published Data Book No. 125, which is a handbook on silent chain-drives. In it is included tabulated information showing transmission of various capacities and speeds, making it easy to select the correct drive for general transmission work.

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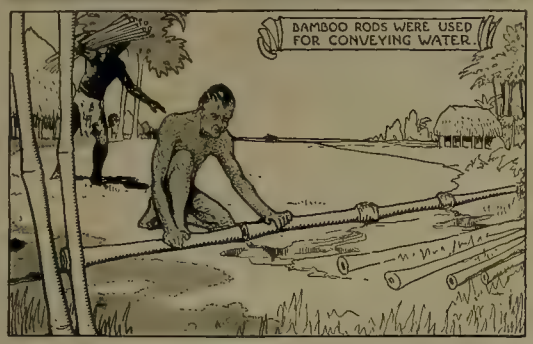
AN INDEPENDENT PAPER OWNED, EDITED, AND MANAGED BY ENGINEERS

STEEL PIPE *and* PROGRESS

PRIMITIVE METHOD



EARLY WELDING PRACTICE

A TWENTIETH CENTURY EPITOME OF STEEL PIPE HISTORY

NATIONAL WORKS of National Tube Company, McKeesport, Pa. Greatly enlarged since this picture was made. Other plants: Christy Park Works, McKeesport, Pa.; Continental Works, Pittsburgh, Pa.; Galvanizing Works, Versailles, Pa.; Kewanee Works, Kewanee, Ill.; Lorain Works, Lorain, Ohio; Pennsylvania Works, Pittsburgh, Pa.; Republic Works, Pittsburgh, Pa.; Riverside Works, Wheeling, W. Va.; Shelby Steel Tube Co., Plant A; Shelby Steel Tube Co., Plant B, Elwood City, Pa.; Syracuse Works, Syracuse, N. Y.; Number of Employees, about 30,000. Largest makers of Pipe and Allied Products in the world. Manufacturing capacity in the neighborhood of one and one-half million tons of "NATIONAL" Tubular and Allied Products per annum. In addition to the plants named above, a new mill has been projected at Gary, Indiana, which alone will have a capacity of about 500,000 tons of "NATIONAL" Tubular products per year.

Look For

The Name

"NATIONAL" Bulletin No. 24—The Rise of Steel Pipe. A copy of this informative publication will be sent free to anyone whose letterhead or position would indicate a legitimate use. Or, "NATIONAL" Bulletin No. 11—History, Characteristics and The Advantages of "NATIONAL" Pipe.

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The Extralateral Right: Shall It Be Abolished?

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Special Correspondence from Oatman, Arizona; Magdalena, New Mexico; Leadville, Colorado; Manhattan, Nevada; Cobalt, Ontario; Porcupine and Kirkland Lake; and Cripple Creek, Colorado.

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PERSONAL 785

THE METAL MARKET 786

EASTERN METAL MARKET 787

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UNION CONSTRUCTION COMPANY

The Union Construction Page

UNION CONSTRUCTION COMPANY

TO MINERS of PLACER GOLD

Investigate the Union Drill. It is easy to operate; it is readily portable and can be knocked down for mule-back transportation and easily re-assembled. It is made in two types, A and B, the latter with steel frame and design for somewhat heavier work than A. The illustration below shows the Type B drill ready for operation. Bulletin 15 gives much interesting data of value to prospectors and placer miners in general. Write for it.

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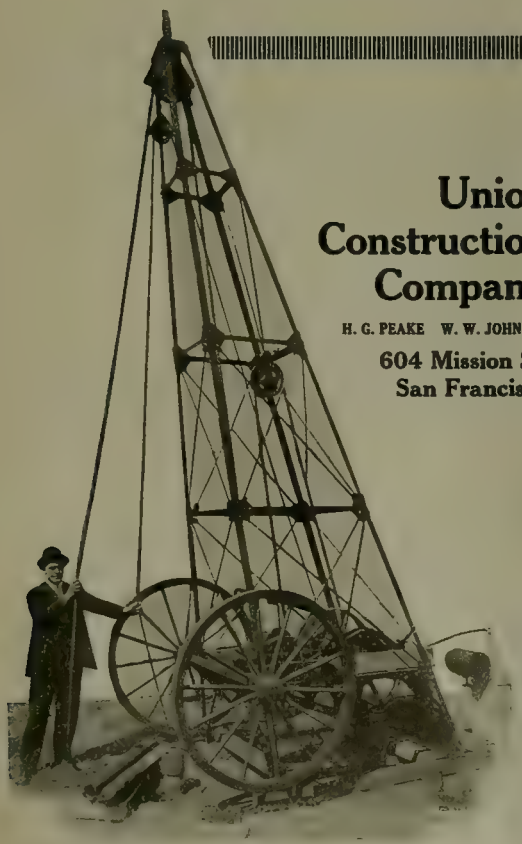

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EDITORIAL

T. A. RICKARD, Editor

CRUDE petroleum coming from Mexican wells is now taxed 10% *ad valorem*, and a minimum value of $9.50 per ton is fixed by the Government as a basis. Double taxes are also levied upon oil wasted through carelessness or failure to comply with legal regulations. Reports that the Mexican government planned interference with the exportation of petroleum is denied by Ambassador Bonillas on telegraphic intruction from President Carranza. He points out that imposts on oil constitute a chief source of national revenue the suppression of which would be suicidal.

ASSESSMENT WORK on mining claims, held as locators or as part owners by officers and enlisted men in the Army or Navy, will not be required until six months after they shall have been mustered out of the service. This is in accordance with a resolution passed by the Senate, which unquestionably will be confirmed by the House of Representatives. The exemption applies to the heirs of such a claim-owner for a like period after his death. To enjoy this relief from the required annual work, the owner must file in the office in which the original location was recorded a notice of his muster into the service of the United States, and of his desire to hold the mining claim under this resolution.

AGITATION for revision of the Federal mining law had its beginning in a popular belief that the so-called 'law of the apex' was the cause of gross injustice and of extensive wasteful litigation. The amount of the injustice imposed by any provision of a statute would presumably be quite accurately gauged by the number of cases arising under it and becoming matters of court decision. The startling fact that out of a total of 5808 cases arising under the mining law during the last 50 years only 115, or 1.9%, related to disputes over apex rights, is brought out in a scholarly article by Mr. William E. Colby printed in this issue. The other 98.2% of mining cases due to different causes indicate what special committees of the engineering societies have also discovered, that the mining law is not merely weak on a major fault-plane, but that it has been considerably brecciated throughout in the effort at adjustment to the enlarged development of modern mining operations. Mr. Colby has made the most exhaustive study of the law of the apex, in this and in other countries, that has ever been undertaken. He speaks with an authority difficult to contravene, and his conclusions should set at rest the anxiety of those who are ever ready for radical reform. He makes it clear that the situation is not such as to warrant hasty meddling with mining law revision, and this is especially true while the attention of the country is distracted by a foreign war.

FUEL economy in reverberatory smelting has been a serious problem in adapting that method to modern requirements in copper metallurgy. Mr. Walter G. Perkins contributes a valuable paper on that subject in this issue, presenting an ingenious application of the regenerative principle to this type of furnace. The attempt is not new, but the practice developed out of the Siemens system, in which the air and gas current was reversed, defeated other necessary objects in copper smelting. The result when using the double-end furnace with the common reversing regenerative chamber is revealed in the failure to secure proper settling of the matte, leaving a slag twice as high in copper-content as is permissible in good reverberatory practice today. Mr. Perkins has proposed a furnace of the accepted form and size in regular practice, with regenerative chambers so arranged that reversal of the air-current through the reverberatory is not required. The details are given in his article, and the results so far obtained in operation are most promising.

JAPAN seizes embarrassing moments to press her demands upon this country for recognition of political privileges that, to speak frankly, could be more readily conceded if her methods were less irritating, and were tinctured with more of the graciousness that endears man to man. There was a time, during the Russo-Japanese war, when our people were filled with enthusiasm for Japan and her people; when proper diplomacy and personal decorum might have won her ardently sought 'most favored nation' treatment to the overflowing lip of the chalice. What happened to spoil it all? It would be easy to write the answer. The latest example in the series of unfortunate chills that we have received from that quarter is the choosing of this particular time to press the whole issue of Japanese admission to American citizenship through the case of Takao Ozawa, which is to be heard in the Circuit Court of Appeals in San Francisco next week. This is understood to be a test case, involving a man of wealth and sustained by wealthy Japanese throughout the country. Friendship is not displayed by trying to settle accounts with a neighbor at a time when he is in difficulties.

MAXIM GORKY once left the United States in dudgeon, declaring that there was more personal freedom in Russia. Apparently the Czar erred on the side of generosity. Morris Hillquit and Algernon Lee have also

found that restrictions upon the license of socialistic agitators in the promotion of strife and trouble are consistent with the institutions founded and maintained by a liberty-loving people now once again fighting for the rightful liberties of man. President Wilson has denied them passports to attend the Kaiser's personally conducted international socialistic congress at Stockholm. It is inconceivable that he could have done otherwise in view of the capture of the recent national socialist convention at St. Louis by Teutophile propagandists, who forced the adoption of resolutions that were signed by the parties mentioned denouncing the "declaration of war against Germany" as "a crime against the people of the United States and against the nations of the world," and further declaring that "the acute situation created by war calls for an even more vigorous prosecution of the class struggle," to which is added the pledge of the members to "continuous, active, and public opposition to the war, through demonstrations, mass petitions, and all other means within our power" together with other definite acts intended to hamper and imperil the United States in these days of stress. It is a pity that the same restraint was not made effective against Lincoln Steffens, whose pernicious socialistic influence has now been transferred, at the instance of Senator La Follette, from Mexico to Russia.

Decision on Appeal in the Flotation Litigation

In Minerals Separation, Limited, *v.* Miami Copper Company, on appeal to the United States Circuit Court sitting at Wilmington, Delaware, the majority of the court on May 25 held the first flotation patent (No. 835,120), second patent (No. 962,678), and the third patent (No. 1,099,699), valid and infringed, according to telegraphic advices received. Detailed comment is necessarily withheld until the arrival of the full text of the decision. The majority opinion was written by Circuit Judge Victor B. Woolley, and affirms that the patentability rested upon the critical proportion of oil and the greater and different agitation resulting in a commercial froth. He holds that the agitation claimed under the patent in suit is found first in the centrifugal pump, second in the break in circuit, and third in the Pachuca tank, but, in the opinion of the court, agitation within the scope and meaning of the patent is not found in the Callow cell. This is based on the ground that no experiments were made in court in producing bubbles in tanks or in the Callow cell without previous agitation in a Gabbett mixer, but the decision holds that if the only agitation to which the pulp was subjected, after such agitation as in the prior art was necessary to mix the oil and the ore, was that given in the Callow cells, the court would not say such agitation amounted to or was the equivalent of the patent disclosures, so as to constitute infringement. It is further held, however, that the Miami Copper Company having used the process covered by the patent in the first three steps, this defendant cannot escape infringement by taking an additional step, even though that step, if taken alone, would avoid the patent. Circuit Judge Joseph Buffington dissented from the verdict, and held that there was no infringement, and that the agitation disclosed in the patent was mechanical, and consequently that aeration is a distinctly different method. It is interesting to note, so rapid is the growth of technical improvement, that even before the hearing in this case had ended the methods of producing agitation to which the verdict relates, had been discarded by the Miami Copper Company, so that the decision is already out of date as regards current practice in flotation. The dissenting opinion should favor the grant of a hearing before the Supreme Court, and the great importance of the issue should result in the Supreme Court admitting a final appeal.

Has the Small Producer a Patriotic Opportunity?

Complaint has been made by an Eastern association of coal miners against the failure of the Government to accord them representation on the sub-committee of the Council of National Defense. Similar criticisms have been made individually in other quarters concerning the absence from the committees on raw materials of persons who might sustain the interests of the great numbers of minor producers. There is justice in that point of view. The committeemen in charge of supplies consist of the leading producers only; the steel committee is made up of Judge E. H. Gary, and Messrs. C. M. Schwab, J. A. Burden, E. A. S. Clarke, A. C. Dinkey, W. L. King, and J. A. Topping, a list that speaks for itself; the copper committee consists of the representatives of the Anaconda, the American Smelting & Refining, the Calumet & Hecla, Utah Copper, Phelps, Dodge & Company, and the United Verde, surely a formidable group. Sulphur is represented by the president of the Union Sulphur Company, nickel by Mr. Ambrose Monell of the International Nickel Company, zinc by Mr. Edgar Palmer, president of the New Jersey Zinc Company, and so on down the list. It is logical and necessary that those who control the bulk of the output should be closely associated with the Government which must know how and where to reach supplies instantly in quantities commensurate with the magnitude of our programme of national defense. Nevertheless, resources of real magnitude in the aggregate are derivable from a multitude of small producers. Narrowing the case down for illustration to the lesser shippers of copper, lead, and zinc ores, it is indubitable that the tendency of the big ore-buyers is to discourage them at the present time. As a result grumbles have become organized into protests, and State politicians have been listening to popular pleas for State smelters, State umpire-assayers, and the like. These suggested remedies we believe to be ineffectual, yet remdies there should be if men can be found wise enough to work them out on a practical basis. It is natural that smelters controlling inde-

pendent resources of ores would prefer to realize upon the reserves in their own mines during a period of high prices, and let the small shipper exhaust his resources and feed the smelters afterward when the ore has a lower market value. This is no more than another instance of the innate unaltruistic Adam, which spirit likewise would move the small miner to apply the same principle for his own pecuniary advantage if he could get the chance. With these fundamental problems of human selfishness we are concerned only so far as relates to the customary governmental forgetfulness of the small fry and the inequities that are permitted to operate against them. One object of a democracy is to be democratic. To pay all regard to the man whose enterprise has made him big enough to be seen above the crowd and forget the others is a bleeding defect in democracy that should receive the attention of the Red Cross corps of the Administration's organization for mobilizing raw materials. Doubtless there is no such corps, but it would be well to take some proper means to insure that the way for the lesser producers to help serve their country in the manner that they know best, which is similar in kind but less in degree than the large producers, is not blocked by these masterful competitors.

A Democratic Bond Issue

The Liberty Loan constitutes a refreshing innovation in democratic finance. Its distinguishing feature lies in the democratic method by which it is being floated. After the Civil War the common reproach hurled at the smug aristocrats who had made money out of Government contracts was that of calling them 'bloated bondholders.' The poor man, the day laborer, the small merchant or farmer, had no chance of getting these desirable bonds. The practice has persisted of offering Government bonds to the highest bidder, in sums and denominations beyond the reach of those possessed of only moderate means. States, counties, and cities almost universally have followed the practice of underwriting bonds through banks and brokers, giving to these a first profit, and restricting the opportunity of the plain people to acquire them in moderate amounts and under favorable conditions. The arguments pro and con need not here be discussed; the prevalent method is sound enough from the standpoint of the financier; it is unquestionably businesslike; but it is not democratic. It helps to define a cleavage between the classes and the masses. The Liberty Loan marks a departure from these undesirable precedents. The man with small savings is given the preference. The bonds are to be sold at their face value, in denominations as low as $50. They may be registered, or 'bearer bonds' can be selected having interest coupons which will be cashed by any bank as if they were treasury notes. It is even possible to buy them on the installment plan, paying 2% on application and the remainder in certain fixed proportions up to August 30 of the present year. Moreover, allotments are to be made to subscribers for small amounts even though it be necessary to reduce allotments on applications for larger quantities. Thus the popular character of the loan will be maintained. It is essentially for the people, and the method adopted is in complete harmony with the object of the War it is intended to assist. Its influence is likely to extend into the future, pointing the way to general participation in the financing of public-utility enterprises, thereby helping to strengthen and purify politics, both local and national.

Response to the appeal for subscriptions has been slower than was anticipated, partly because the exceedingly democratic provisions fixed by the Act of Congress authorizing this $2,000,000,000 issue of Government bonds were not immediately understood, and partly because a false impression that the market would instantly absorb the first issue gained currency from some indiscreet official announcements. The impression was easily obtainable from these earlier comments that the old financial cliques were ready to pounce upon the bonds, leaving the public as usual to pay the bills but get none of the profits. This is contrary to the fact. He who can buy one $50 bond will be sure to obtain it, while he who subscribes for $50,000 worth must take pro rata what is available after the small subscribers have been satisfied. The bonds bear interest at the rate of 3½%, and are exempt from Federal taxes. It is estimated that they are equivalent to ordinary corporate bonds or other investments bearing 6½%, and their safety is infinitely greater. It is practically the same thing as having money on deposit drawing interest. They will constitute the most liquid asset that one could have in time of stress. Uncle Sam is the most reliable of all debtors; if his credit weakens it will mean that the Nation has been worsted and is at the mercy of a victor, in which case nothing would possess convertible value.

Mining on the Rand

It is a good thing occasionally to see ourselves as others see us, hence the friendly criticism of so intelligent a visitor as Mr. H. Foster Bain ought to be appreciated at Johannesburg. We publish the second part of a long and well considered article by him entitled 'Mining Problems on the Rand.' To those unfamiliar with South Africa the article will convey much interesting information, and it may do something better, by suggesting the application of a similar analysis to their own methods of mining. The Rand is big enough to stand a good deal of criticism. In 1916 the production of gold from this one district, not the whole Transvaal, was worth £38,107,909, which is the highest recorded up to date. During the year the tonnage increased by 210,600, but the so-called working cost advanced 8 pence or 16 cents per ton, the highest since 1907. However, this 'working cost' represents only a fictitious apportionment of the total expense, for while the 'working profit' was £11,630,001, the total of dividends was only £7,095,000. Thus the dividends represent only about 60% of the nominal profit. Similar illusory sta-

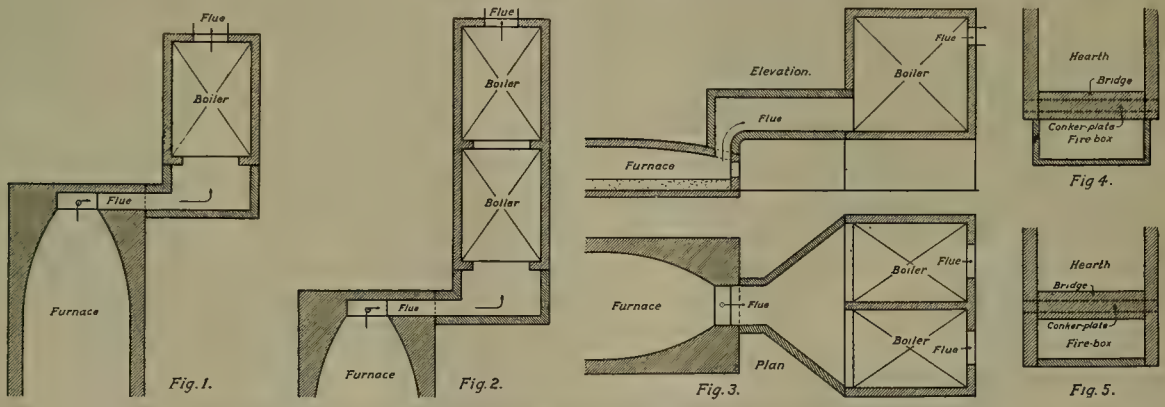
tistics are published by the Chamber of Mines. It is curious that the anomaly should be tolerated year after year, rendering ridiculous the otherwise excellent information published by the organization that so efficiently represents a great industry. It is curious that Mr. Bain does not animadvert on this discrepancy between fact and fancy. However, he makes criticisms, possibly of a more useful kind, illustrated by comparisons with large-scale mining in the United States. The comparative regularity of the lode-structure and the relatively homogeneous character of the ore are features that were emphasized more confidently in an earlier decade; the vicissitudes of mining have not been lacking on the Rand, and as the great goldfield becomes old it develops the weaknesses common to age. Nevertheless the seams of gold-bearing banket have given us a type of lode truly remarkable, and the exploitation of them has been conducted on a scale and with an energy such as was undreamed until the Utah Copper and the Chuquicamata set a new standard. The Rand, of course, profited enormously by the financial support given by London, Paris, and Hamburg during the days of its adolescence. The Mexicans say that it requires a gold mine to make a silver mine; it needs capital to develop a low-grade gold mine, and the Rand never lacked capital in the days of its youth. That was due largely to the group of clever and forceful financiers that fathered the plans for deep and extensive mining, when clear-sighted engineers, such as J. S. Curtis, H. C. Perkins, and Hennen Jennings laid them on the board-room table. Those spacious days are over and capital is now less venturesome. Mr. Bain refers to an increase of caution, for mistakes are now less easily retrieved, and mines that are over-bought or overcapitalized cannot be foisted on the public as in the halcyon times when the big fortunes were made. The engineer has come into his own, and technology dominates finance. Mistakes are not so easily covered, the director is reminded that he is a trustee, and the shareholder becomes less timid in asserting his proprietary rights. Mr. Bain discusses some of the vagaries of the London mining market with a gentleness amusing to one better acquainted with the manner in which the working of the mines has been subordinated to share-deals by the 'houses' or 'groups' that control the important companies operating on the Rand. He refers to the way in which an effort was made about ten years ago to achieve a low cost per ton by 'wholesale' mining, that is, by milling an excess of waste, and how the folly of it was so slowly recognized, but not before a series of consolidations, creating super-mines, had enabled the big houses to bury some of their blunders and to get rid of a lot of poor property at the expense of the public. All mining is selective. The purpose of mining is not to create alluring statistics but to make money. Anything that has to be deducted from the yield is part of the cost and the true profit is that part of the yield that reaches the pockets of the shareholders. These are axioms that the big operators and promoters in London and Hamburg buried deeply in sophisticated finance and intricate reports. However, much of that belongs to the past; the question is how to profit by experience and make the most of the remaining resources of this wonderful goldfield. Mr. Bain offers many practical suggestions, based undoubtely on a discussion of the subject with some of the engineers most familiar with local conditions.

The close saving of the ore, and the redemption of pillars in old workings, are good points. In this work the experience of the coal-miner should prove useful because the conditions on the Rand, as regards dip, walls, and extraction, resemble in many respects those obtaining in coal mining. That is why colliery-engineers have found favor at Johannesburg during the last ten years. Such men ought to be effective there, provided they have had an opportunity to see something of gold mining in other regions before going to South Africa; otherwise they are likely to be too dogmatic. Underground haulage is another important problem. Here the experience of other regions should prove useful, for the last word has yet to be said on this subject. Obviously an exchange of visits between the managers of mines in various parts of the world is the best way of attacking this problem. Insularity is inexcusable in technology, and American engineers are as prone to this defect as others, but not without the excuse that the United States affords a wider range of observation than any other continental area. The Michigan mines used to be antediluvian in their methods, and the Mother Lode region in California likewise has been far behind the times in its technical practice. Self-satisfied conservatism is not peculiar to any one locality, either north or south of the equator. Mr. Bain refers to the custom of keeping a reserve for sweetening the returns, and explains how it was misused—as it was sure to be. The silly custom, with its many deceptions, arose out of the effort to square the speeches of chairmen and directors with the vagaries of ore deposition. The public was asked to believe that mining was an investment, and that the regularity of gold production could be likened to the smoothness of manufactured output. These representations had to be made good by the mine-managers, and the only way to do so was to hold a reserve of gold in the safe, or of amalgam in the mill. By this time the public has learned by bitter experience that uniformity of statistical returns is a delusion and a snare; yet the fiction is still maintained by many companies having headquarters in London, and by some controlled in such centres of enlightenment as Boston and New York. It is time to puncture the fallacy. Ore deposits, particularly those valuable for gold, are subject to variation of composition, necessitating a variable output. The endeavor to maintain a uniform yield entails either juggling with figures or, if it be real, it is obtained at an expense that may well be avoided for the sake of ultimate profit. The result of a mining enterprise should be measured not by the cost per ton or the output per month, nor even the profit per annum, but by the total money divided among the proprietors in a period that enables them to make the most use of that money.

Non-Reversing Regenerative Furnace for Copper Smelting

By WALTER G. PERKINS

It is difficult to give an exact chronological statement of the progress that has been made in the construction of reverberatory furnaces and of reverberatory smelting practice in the last 20 years. It is sufficient to say, in general terms, that the utilization of waste gases began about that long ago and has brought the reverberatory furnace into the field of economics in modern copper metallurgy, whence it has been relegated to second place by the development of the blast-furnace. This development has had many direct and indirect influences on the art, aside from economics alone, as, for example, it has re-constructing the existing plant. This scheme worked so well that Karl Eilers followed the practice in the construction of the Garfield plant. The next organized radical changes were made by myself in the design of reverberatory furnaces for the Steptoe plant of the Nevada Consolidated Copper Co., where I placed the waste-heat boilers, as shown in Fig. 3. This method has since become practically standard, and has the advantage of giving a better waste-gas distribution to each boiler, as against the tandem method when the first boiler absorbed 60 to 65% and the second was little better than a



DETAIL OF BOILER-SETTINGS AND FIRE-BOXES AS PER CURRENT REVERBERATORY PRACTICE

solved the problem of smelting fine ore and concentrate derived from water concentration and from the flotation process. There were many attempts made to apply the use of the lost heat-units in the waste gases from reverberatory furnaces that constituted from 30 to 50% of the total heat-units produced by the burning of the coal on the furnace grates, by placing steam boilers in the current of the waste gases immediately in front of the throat of the furnace.. This was accomplished with considerable success, but the first systematic effort recorded is that by Frank Klepetko at the Washoe plant, where two banks of 50-ft. reverberatory furnaces were built, each with a Sterling boiler attached, placed on the ground at the side of the front of the furnace, as shown in Fig. 1. Later E. P. Mathewson and his staff converted these into furnaces 110 ft. long, with two boilers to each furnace, placed tandem, as shown in Fig. 2, thereby instituting the long-furnace scheme which represents one of the greatest strides in modern copper-smelting practice. The idea of placing boilers tandem was probably suggested by the fact of this being the most convenient method of water-heater. The later development of the scheme is to take the gases from several furnaces to a common longitudinal flue placed at a right angle to the main axis of the furnaces, and to set the boilers in a battery, drawing the gases to or cutting out any individual boiler as the case may be. I also tackled the fire-box end by changing the construction, which had been carried out in practically all reverberatory-furnace construction from time immemorial, of making a right-angle off-set in the furnace immediately behind the bridge-wall and the conker-plate, as shown in Fig. 4. This limited the width of the fire-box and consequently the amount of grate-area on the width-dimension. I therefore designed the Steptoe furnaces on the lines as shown in Fig. 5.

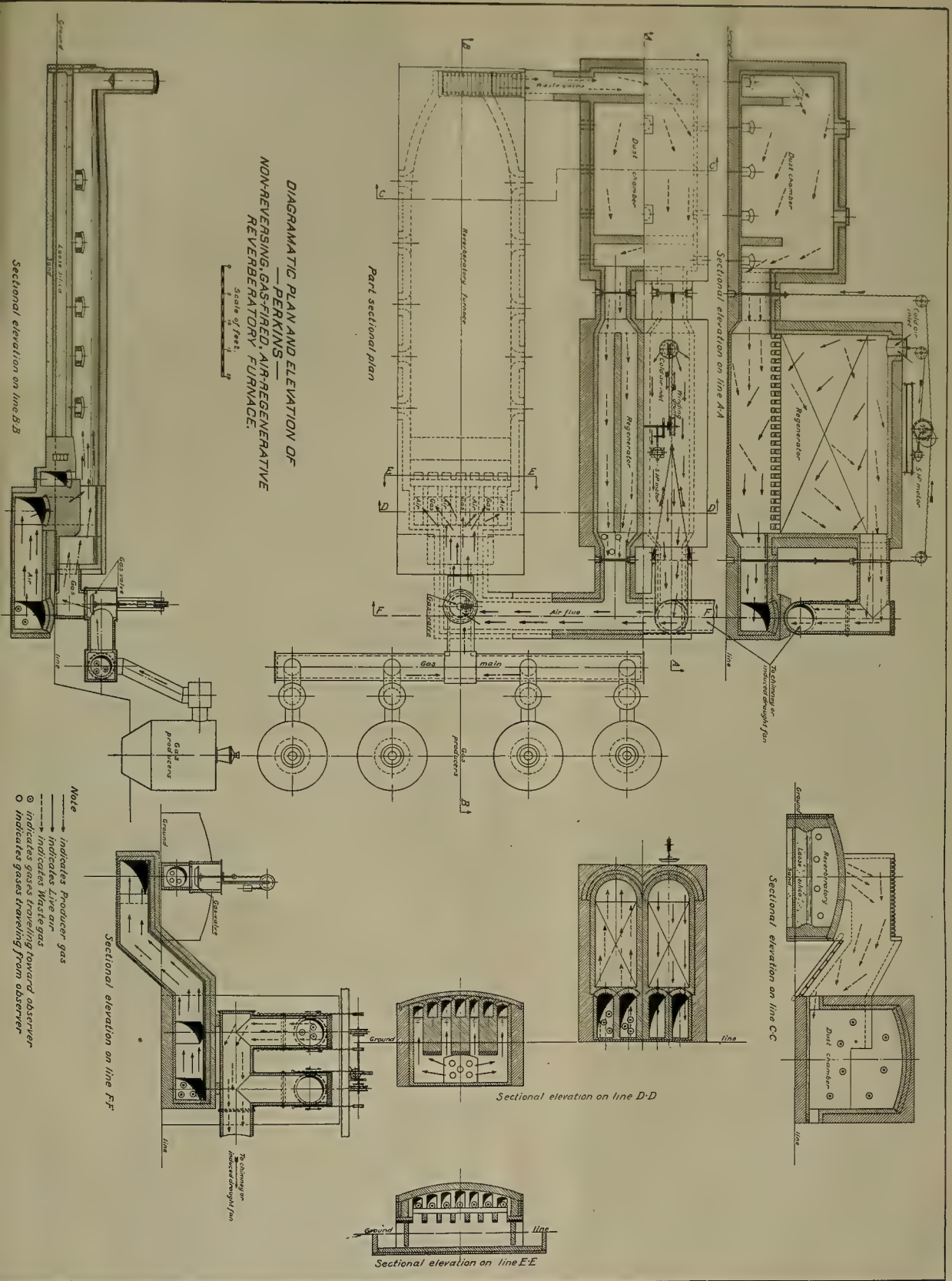
This method allowed for a fire-box the full interior width of the furnace, with its consequent greater grate-area, and it fully justified itself, as these furnaces have shown that from a standpoint of furnace-capacity the old idea of establishing a necessary ratio of square feet of hearth-area to grate-area has little reason to sustain it, because if the grate-area is large enough to burn enough

fuel properly, there is no necessary limit to the tonnage that can be smelted on any square foot of hearth-area. At that time (1908) the Anaconda plant was smelting about 250 tons of hot calcine, making slag of about 37% SiO_2, and 40% matte, whereas the Steptoe furnaces smelted 400 tons of hot calcine, making a 45% SiO_2 slag and a 60% matte in furnaces of the same dimensions.

Oil and coal-dust firing have effected great economic changes, but the principle of waste-heat boilers attached to reverberatory furnaces remains the established modern design. The boiler department is a necessity in order to make reverberatory smelting an economic possibility on account of the fact that the reverberatory furnace itself is not economical in its use of fuel and it requires the waste-heat boiler as an auxiliary to use the heat-units that the furnace itself wastes. There is no doubt that, if the many conversations that were held by technical men prior to the time when waste-heat boilers came into general use had been recorded for gramophone entertainment, and these conversations should now be repeated, they would prove interesting and amusing. All ideas are developed slowly, and they not uncommonly result in relegating the 'beaten-track' prophet to the limbo of the past. There are few metallurgists that have been associated with reverberatory work who believe that a boiler plant as an adjunct to a reverberatory-furnace plant is either scientific in principle or entirely satisfactory in operation, and there is no doubt that in the pioneer days many failures ensued before the details of the successful operation of the reverberatory furnace with an attached boiler plant were worked out. Many metallurgists have at some time considered that a reverberatory furnace worked out on the regenerative system would be superior if the inherent problem of keeping the checker-work clean could be solved. No unit in a plant can be termed a scientific accomplishment if it is necessary to have an auxiliary unit attached to it so radically different from the prime unit as are steam boilers in order to make the prime unit an economic possibility, especially when the auxiliary waste-heat boiler-unit has to be worked in a manner which cannot from any point of view be considered good boiler-practice.

Regenerative furnaces that pre-heat the gas and air, and others that heat the air alone, have been used for many years, but nearly all have been of the reversing end-over-end type, as used in steel-practice. The rejection of this type of furnace was primarily because of the clogging of the checker-work with dust going over with the fume; but with the development of the long furnace a metallurgical objection also became an issue in the form of higher slag-losses as shown at Anaconda where long single-end furnaces showed a loss of 0.35% copper as against the Great Falls double-end regenerative type with a loss of about 0.60%, operating under the same metallurgical conditions. The long single-end type does the bulk of its smelting in the first 50 ft. of length from the bridge-wall, thereby allowing the front end of the furnace to take care of a small portion of the smelting, but giving a large quiescent area for allowing the more complete separation of the small globules of matte from the slag by gravity settling. The double-ended regenerative type of furnace, on the other hand, viewed from a copper-smelting standpoint, is to all intents and purposes two furnaces placed end to end without a dividing wall, and smelting alternately, first on one end and then on the other, and this does not allow any constant quiescent area for the separation of matte from slag. Aside from the two objections enumerated there is one more factor that has exerted an important influence on the development of reverberatory furnaces, and I am not sure that it is not the most important, namely, the plentiful supply of long-flaming coal, rich in volatile constituents, with B.t.u. value of 12,000 to 12,500, such as exists in the Wyoming and Utah coals, used for smelting purposes in Montana, Utah, and eastern Nevada; and the crude-oil supply employed in the Arizona and Nevada smelting plants. These high-grade fuel supplies, coupled with the working out of the use of the waste-gases from reverberatory furnaces, have made it unnecessary to give serious attention to overcoming the difficulties encountered in the proper application of the regenerative principle to reverberatory furnaces for copper smelting in western America up to the present time.

There are, however, two conditions in copper metallurgy where reverberatory smelting even in furnaces with waste-heat boilers attached, is not practicable. The failure may in some cases be entirely economic, as for instance where cheap power from a hydro-electric plant is available, nullifying the value of the waste-gases, thus throwing the entire fuel-expense on the cost of smelting proper, as there are no waste-heat credits to be obtained from the power-plant; or where the available fuel (coal) has a low B.t.u. value, probably combined with physical difficulties which make it impractical to burn it direct on grates or as coal-dust. The latter condition came up in my practice in the Ural mountains, and it was necessary to solve the problem. Reproduced herewith are diagrammatic sketches showing the outline of the furnace and its regenerative chambers, with the flow of the gases and air, a plant that was evolved after much study. The work started with the designing of a large double-ended furnace modified in accordance with modern practice in copper reverberatory-smelting. Later a full set of drawings of the single-end non-reversing furnace was placed in the hands of the Russian operating engineers of the Kyshtim Mining Works, who modified them in some details to suit local conditions and their own ideas, but in the essential features and principles my plans, which are covered by patents, were followed. This furnace has been in operation, although the work has been hampered for want of coal. I visited the plant last summer when they had enough fuel for about a six-weeks campaign, and am able to record that it was a complete success; in fact, I have never seen a reverberatory furnace that carried such an even and continuous temperature throughout its whole length without discharging an impossible quantity of waste-gases. The records are not sufficiently complete to give them in detail, but I can say that I calcu-


DIAGRAMATIC PLAN AND ELEVATION OF —PERKINS'— NON-REVERSING, GAS-FIRED, AIR-REGENERATIVE REVERBERATORY FURNACE.
Scale of Feet
Part sectional plan
Sectional elevation on line A-A
Sectional elevation on line B-B
Sectional elevation on line C-C
Sectional elevation on line D-D
Sectional elevation on line E-E
Sectional elevation on line F-F
Waste gases
Dust chamber
Regenerator
Reverberatory furnace
Air flue
Gas main
Gas producers
Ground
line
Note
indicates Producer gas
indicates Live air
indicates Waste gas
indicates gases traveling toward observer
indicates gases traveling from observer

lated the metallurgical charge and the fuel used to the basis of American practice, and found that it was equivalent to about 12% on a basis of 12,000 B.t.u. coal and a hot calcine charge. The temperatures in degrees Fahrenheit were: bridge-wall 2732°, throat 2372°, stack 450°, and hot live-air to furnace 900°. The coal that is being used is about 8000 B.t.u. value, low in volatile matter, and with 30% ash. The clinker produced would be impracticable to work on direct-fired furnace-grates, and it causes great difficulty in the producers on account of forming large masses of clinker. The gas produced is of poor quality by virtue of the low volatile content of the coal. From my observation, I think there is little doubt that, with high-grade coal, making a good gas, this furnace would stand a chance of showing better fuel-economy than any combination of furnace with waste-heat boilers attached. This is shown by the low temperature of the stack gas (450° F.), and the high temperature of the live-air coming from the regenerative chambers, which has at times registered as high as 1200° F. I also think that there is obtained probably a greater tonnage-capacity per square foot of hearth-area, as the heat is carried in a more uniform manner throughout the entire length of the furnace without excessive loss of flame at the throat. This latter condition would probably lessen the copper-loss in the slag.

Another factor of importance is that the air and gas can be so controlled that the free oxygen in the waste-gases can be regulated in such manner that either a reducing or oxidizing atmosphere can be maintained in the furnace, which in turn reduces or increases the sulphur-loss by volatilization in the smelting process. This in some plants is an important factor, where the mineral being treated is largely bornite or chalcocite, producing matte of a high grade to the extent of interfering with the economics of the converting operation. This condition would be produced at the expense of fuel-economy in smelting proper, so that the question whether sulphur or coal is of the greater value would have to be determined in each case. The fact, however, remains that this furnace does permit in some degree of the regulation of sulphur-volatilization, which is impracticable in any direct-fired furnace.

In conclusion, it appears to me that the non-reversing regenerative type of furnace has many advantages over any system in which there is used the combination of a furnace with waste-heat boilers attached. The reasons are: (1) it consumes all the recoverable heat-units itself, and is a complete machine, requiring no auxiliary apparatus to make it economical; (2) it allows the construction of the power-plant as a complete unit, on lines conforming to the best practice, creating an economy in the cost of power. The mechanical engineer does and always will consider that having to take steam from reverberatory waste-heat boilers does not give him a chance for good power-practice, although at the present time he has no alternative, as the power-plant must take second place to the reverberatory-furnace section; (3) central or hydro-electric power would become of more general use if the reverberatory furnaces themselves consumed all the heat-units they produced, leaving the power-factor as an independent unit to be developed along the most economic lines; (4) this furnace can be adapted to coal-dust or to oil-firing, still maintaining the regenerative principle, or it can be used with producer-gas; (5) if the fuel is of high quality the results will be excellent; but even if the fuel is of poor quality, or in fact valueless for any direct-firing system, reverberatory-furnace smelting is still economically feasible, as indicated by the Kyshtim operation, and does not preclude the using of large furnaces and adopting modern metallurgic practice with low resultant costs of smelting.

Platinum in Spain

By F. GILMAN

*Spain has long been noted for its ores of mercury, silver, lead, zinc, copper, iron, and sulphur, and three years ago potassic salts were discovered in the rock-salt district of Cardona in Catalonia. Now the turn of platinum appears to have arrived. In 1913 Domingo de Orueta, a mining engineer and member of the council of the Spanish Geological Institute, during a field-study of the peridotites in the Ronda highlands, in Malaga, became impressed by the analogy between the dunite, harzburgite, and other basic rocks of the district and those of the platiniferous district of the Urals. After a petrological examination of both the Spanish and Russian rocks, Orueta confirmed his surmise. The field of operations was the huge mass of partly serpentinized peridotites which extends from near the Mediterranean at Estepona north-east as far as Tolox, a distance of 25 miles, with a width of 8 to 10 miles, rising in several transverse ridges to heights of over 3000 ft. From numerous borings the samples weighing from 30 to 40 kg., were submitted to analysis. The majority proved to be platiniferous, the metal generally appearing in the form of minute, rounded, or flat grains, with a maximum weight of about 2 gm. It is associated with chromite.

The platinum is concentrated in the stream gravels on bedrock and covered by a practically barren overburden from 25 to 30 ft. thick. About one-third of the borings yielded platinum at the rate of 1.5 to 2 gm. per cu. yd., while more than a third contained 20 to 30 gm. The Malaga platinum contains by assay from 78 to 82% Pt, associated with palladium, rhybidium, and other rare metals. The original tests were made at Orueta's expense but government aid has now been granted.

SALT-CAKE is sodium sulphate, a by-product from the manufacture of hydrochloric acid. The most common method of making this acid consists in boiling common salt with sulphuric acid in cast-iron kettles. The reaction is: $2NaCl + H_2SO_4 = 2HCl + Na_2SO_4$. The salt-cake contains also some water of crystallization.

*Abstract: Bull. Inst. Min. & Met., April 1917.

Mining Problems on the Rand—II

By H. FOSTER BAIN

The question may fairly be raised whether Rand mining really lends itself to the methods necessary if the full benefit of mammoth units is to be realized. Consideration of the uniformity in character of the ore indicates that so far as milling is concerned there is no difficulty; it will be more a matter of mining and transporting it economically. We must remember that the gold-bearing layers are thin. While there are stopes 15 ft. wide, it is significant that thicknesses are usually stated in inches. W. L. Honnold speaks* of "a rough average of 33 in. which may or may not include quartzite partings." Such a thin orebody will always necessitate a considerable length of cross-cuts, drifts, winzes, and raises per ton mined as compared with the thick, even if irregular, orebodies of other districts; in other words, the ore to be mined is scattered through a wide area. Neither is it continuous or uniformly distributed. That the valuable ore occurs in patches is now generally recognized so far as the Far East Rand is concerned. That it occurs in patches on the Central Rand is also true, although so far the individual patches have proved large and the presence of several parallel ore-beds has both disguised the real distribution and reduced the amount of sinking and cross-cutting necessary per ton, without affecting the amount of driving in banket. According to the report of R. C. Warriner for 1915, only 55.1% of the 6150 ft. driven that year on the reef in the western section of Crown Mines showed ore of profitable grade. In the eastern section, the corresponding figure was 45.3% of 6730 ft. In the East Rand Proprietary the percentage for 1914 was 67, and for 1915 it was 57; taking the Hercules alone, it was 40, and for the whole group to date 45%. It should be remembered that these are deep mines now. Along the outcrop and to considerable depths the ore-shoots were much more continuous along the strike. These figures, however, are not out of line with those in the Far East Rand where the Brakpan, according to Mr. Honnold, showed 50% profitable ground, and Springs for the past year has shown 53. R. N. Kotze, the Government engineer, has taken 40% for a safe average for that district. The steeper dip on the Central Rand increases the tonnage per acre and the total amount easily made tributary to any one shaft, but the fact remains that there is not the same opportunity for centralizing hoisting here that exists in other metal mines.

If, however, analogy be sought in another direction the situation is more hopeful. Many thin coal-beds are worked over large areas, the coal being brought to one central shaft, and, when the mine has been laid out with that in view, a surprisingly low cost is realized. The actual breaking of coal naturally costs less than in the case of Rand banket, but so long as comparisons are on a tonnage basis it is difficult to see why a bulky material such as coal should be transported and hoisted at less cost than Rand ore. It is also difficult to believe that general costs of ventilation and supervision need be greatly more in a Rand mine, even with its dust, than in a gaseous and dusty colliery. Indeed the analogy is close between the opportunities on the Rand, especially in the Far East where most of the new mines will be opened, and in a modern coal-field. In my judgment the greatest opporunity for further improvement on the Rand is in the underground work and the best chance of success, especially in the Far East where it is to be presumed that most of the new mines will be opened, is through assimilating and adapting coal-mining methods, though perhaps something could be learned from studying the mining of thin-bedded mineral veins such as the Clinton iron ores of the United States. The most striking changes made in recent years in underground practice on the Rand have been introduced from the collieries either by engineers who had had practice in them or by Rand engineers who went to them to study methods. The Consolidated Mines Selection company, in fact, grew out of successful ownership and operation of collieries. At the Lonely Reef mine in Rhodesia excellent points in practice have been introduced from the experience of the Lewis & Marks engineers in coal mining. This brings up the consideration of the third method suggested for meeting the problem of increasingly lower grade of ore, namely, improvement in technical practice above and below ground.

The major operations of mining involve breaking and loading the ore, transporting it to the shaft, and hoisting it to the surface. The first step involves drilling, blasting, shoveling, and takes somewhat different forms as between development-faces and stopes. Incidental to the mining itself there must be subsidiary services designed to protect, ventilate, drain, and illuminate the workings, all of which involve supervision. The rock mined on the Rand is "the hardest on earth." Rand miners and engineers will admit this themselves. Curiously enough "the hardest rock on earth" also occurs in the Lake Superior mines, at Treadwell, Alaska, at various points in Canada, Mexico, Australia, and, in fact, at most of the mines it has been my fortune to visit. At each, unimpeachable local evidence can be brought forward to sustain the claim. Indeed the Rand banket, a thoroughly silicified conglomerate, is hard, but it may be questioned whether it is so hard as to make it out of the question to hope for a higher drilling-speed. Ac-

*Bull. A. I. M. E., August 1915.

cording to figures presented to the Economic Commission by the Chamber of Mines, the average footage per machine-shift is 21½ ft. Allowing 45 minutes per 6-ft. drill-hole it was estimated that the actual average drilling occupied 2 hours and 41 minutes, including the time taken in changing bits. There would seem to be room here for improvement in increasing the effective working-time, also possibly in increasing the speed of drilling. The air-pressure used for drilling on the Rand is about 80 lb. and miners believe that at higher pressure neither drills nor steel would stand up. Drills, of course, can be built for any reasonable pressure and are regularly used at 100 lb. and more in many mines. On the Rand the wings of a bit are subjected to great abrasion, especially in the case of hammer-drills where the action is similar to grinding on a stone. It is not easy to get drills that follow because of quick loss of gauge. The main difficulty with drill-steel is probably due, to an unsuspected degree, to poor or rather irregular blacksmithing, though this is being greatly improved by the use of drill-sharpeners. Loss of drilling-time is in no small measure due to inadequate supplies of steel, poor organization of delivery, and faulty tempering. By close attention to these details, coupled with the use of but one type of drill in the mine and that the water-drill, at Modderfontein Deep, a marked improvement on general practice has been made and while with native labor perfection is not to be expected, improvement may. In an excellent little book called 'Practical Mining on the Rand' and in an article in *The Mining Magazine* of August 1915, E. M. Weston discussed drilling problems in such great detail that little remains to be said. He has also made pertinent suggestions for changes in the work. It seems probable that under Rand conditions improvement in this department can only be expected through patient and unremitting attention to small details and that the gain will be slow. In other words, there does not seem to be any opportunity for revolutionary introduction of machinery or methods such as that of the one-man drill in the Lake Superior copper mines.

In blasting there has already been marked reduction in cost as an incident to the War. Finding it impossible to get materials for making the explosive that had been previously used, substitutes were offered and with slight changes in method of work the new explosive was found to give as good results at less cost. The whole list of stores purchased has received careful study since the War began and in several directions it has been found possible to economize.

In driving a development-face, the cut and the round are often blasted on separate shifts. This is done in order to avoid the necessity for men going through the dust to the face to charge the round after the cut has been blasted. It has the advantage that the remaining holes can be placed to better advantage after the miner sees just what the cut broke, but it has the disadvantage that progress per face is a trifle less than half what the usual plan would allow, and to secure the same development there must be a much larger investment in main haulage-ways, deep winzes, and other principal passages. In view of the fact that not more than one drill-shift in 24 hours at a face is permitted in Rand mines the rate of progress, even with normal organization of work, would be slow. It is not to be forgotten that the serious handicap to deep mining is the slow rate of development, having in mind the heavy initial investment in shafts. While development is charged off usually at 2s.6d. per ton, the cost of advance-tonnage prior to milling is about 4s. in the case of deep mines. Even after the mill is erected and in operation the bringing of ore into reserve is disappointingly slow and expensive; and it would perhaps not be too much to say that this is the most critical factor from a technical point of view as regards the future of deep mining. Every effort is made to push development; the slow speed is due in part to the physical conditions and in part to the regulations, which prescribe the manner in which work must be conducted. Any plan that will decrease the footage necessarily held in reserve is worth considering and there would seem to be an opportunity here for the 'delay-action' fuses used in other districts. With them both cut and round can be blasted in sequence without any one going into the dust. The same result can be accomplished, although not so satisfactorily, by cutting fuses to different lengths and firing blast and round at the same time. This is done at some Rand mines. Making it the rule to drill and blast the whole round on a single shift would virtually double the rate of progress at each development-face and so reduce by one-half the number necessary to keep going at one time. It will interest miners in other regions to learn that it is not uncommon for a stope-face to progress only four feet per month. This slow rate of progress entails a heavy overhead cost per ton.

After the rock has been broken in drift or stope, it costs about 2s.2d. per ton to shovel (or 'lash,' as it is locally called) it down the slope, into the boxes, and to haul it to the shaft. In view of the confined space in the workings there is little hope of introducing mechanical shoveling and it is only in special situations that conveyers are economical. In the future mines of the Far East Rand the best plan will doubtless be to convey the trucks direct to the face as is customary in coal mining and as has been described by Mr. Honnold in the article to which reference has already been made.

In stoping, one of the items of expense is the support of the roof. On the Central Rand the roof is so good that it will stand over wide areas for long periods. Indeed the great size of the open stopes is at once a matter of surprise and apprehension to visitors. That the apprehension is not entirely without justification is indicated by the earth-tremors that have become fairly frequent at Johannesburg. These have their origin in the caving of old stopes. Sand-filling is being employed at a number of properties with excellent results and may be expected to become a regular feature of practice in the deep mines where the dip is steep. It is to be regretted that the method was not introduced earlier, for wide

areas of old workings now exist where any general settlement once started cannot be controlled and loss of the remaining part of the mine will probably result. The method of filling with sand has been described in detail by W. A. Caldecott and O. P. Powell.†

In the flat-lying beds of the Far East Rand, sand-filling through bore-holes is not practicable, and in the deeper mines the roof is weak and troublesome. It is held by using 'dry' walls, by 'cribs' of wood filled with waste rock, or by leaving pillars. Each method is expensive and unsatisfactory. Where cribs are built they must cover from one-fourth to one-third of the area of the stope and as the weight comes on them they squeeze down so that they are at best of temporary value. Part, but not all the timber can be recovered when the stope is abandoned. Fortunately the ore over much of the Far East Rand is so distributed that the workable bodies form a series of irregular bodies, which in the Brakpan are so distributed as to form natural panels separated by permanent ribs of barren ground. These ribs are of such size as to preclude danger from a general squeeze. The general plan of operations at the Brakpan is to cut across the course of these oblong patches of ore with the main cross-entries, make rises through them from level to level, and then stope from both sides of the rises to the limits of profitable ore. In the other mines the patches of ore are cut by drifts and winzes as circumstances dictate and then worked outward from these passageways. It is in this last phase of the work that pillars are left or packs built, in the effort to take the ore as clean as possible while the face advances. The question arises whether it would not be more profitable instead to drive from the rise a series of roads laterally to the boundary of the patch of ground to be worked, connect them at the ends, and then work back to the main rise by retreating long-wall methods. Where the roof is favorable this would obviate the necessity for any packs, would use the weight to best advantage in bringing down the rock, and would keep the men under cover. As against advancing work with small pillars it is to be remembered that in coal mining it is a rule that the maximum profit is won from doing the minimum amount of mining on the advance, that it, the most profitable pillar is larger than the one used merely to support the roof. Even under poor roofs it is a question whether more ore might not be mined on the Rand when retreating. The proposed plan would require a larger investment, but it would render the workings safer and it should prove economical. To test the matter would require careful figures based upon actual experience at a particular mine.

†Jour. Chem. Met. & Min. Soc., S. A., Sept. 1913.

Transport of materials underground on the Rand is usually effected for short distances by hand-tramming or trucking. Longer hauls are commonly accomplished by endless ropes, a system that has great vogue in Africa, but electric and petrol locomotives are also in regular use, while experiments are being made with storage-battery locomotives. The advantage in cost seems to be with the rope, where the roads are sufficiently straight to allow its use. Thus at the Geduld rope-haulage costs 9.8d. per ton and at the Modder Deep, with a larger tonnage, this comes down to 3.89d. Electric haulage at the Geduld costs 12.057d. per ton but the track is of 18-in. gauge, and crooked, grades are of 1%, and for fear of accidents to workmen the voltage is held down to 240.

THE CORNER HOUSE, THE HEADQUARTERS OF THE CENTRAL MINING & INVESTMENT CORPORATION

It is difficult to get exact comparisons, but the following figures from the Crown Mines are suggestive of the advantage of a system of storage-battery motors for gathering, with delivery to main haulages operated by ropes or electric locomotives.

	Tons	Cost per ton, Pence
Electric locomotive	124,535	2.7
Petrol locomotive	30,911	4.7
Endless rope	25,037	1.9
Storage-battery	13,875	1.4

These figures are suggestive only, as they do not take into account the effects of varying distances and conditions. In discussing the transport of materials with especial reference to work above-ground, C. O. Schmitt* has given much interesting detail regarding rope-haulage and pointed out its limitations.

Having gone to the Rand full of the current idea that it is the field pre-eminently of large-scale mining, it was somewhat of a shock to find the small amount of ore hoisted per day per shaft. It has already been shown that there are only five companies that treat more than 75,000 tons per month and all of these pull from more than one shaft. Nearly half the companies are content with less than 50,000 tons per month and a manager who delivers 60,000 tons per month through two shafts and at the same time handles men and supplies, considers that his record is exceptionally good. This is the more surprising in that the mines are generally dry, they require little timber, and the larger part of the men are underground but one shift. It is true that depths are considerable, but in hoisting it is the starting and stopping that consumes time. Increase in depth does not increase proportionately the time needed to bring a skip to the surface. By way of comparison it may be mentioned that collieries in Great Britain are equipped to hoist 5000 to 6000 tons in two shifts from a depth of 2400 ft. Collieries in Illinois hoist 800 tons per hour from a depth of 700 ft., and it is to be remembered that in colliery practice self-dumping skips cannot be used. The Inspiration Copper Co. in Arizona, using twin shafts, is hoisting 10,000 to 14,000 tons per day of 14 hours from a depth of 630 ft. In this case the hoisting is done automatically by means of 580-hp. direct-current motors, one for each shaft. The engines, having been started, continue to hoist automatically-filled, self-dumping skips until stopped, or until some one of the numerous self-acting safety-mechanisms comes into play. To return to gold mining, it may be mentioned that the new hoisting arrangements at Treadwell in Alaska are designed to handle 5000 tons per day from a depth of 3000 ft. It is not intended to suggest that conditions are the same as on the Rand, but, having in view the great expense of shaft-sinking, too little use is made of a shaft when it is once down. Probably the most striking contrast with Rand hoisting practice is afforded by the Kimberley diamond mines. At the Du Toits Pan 7024 tons was hoisted from 750 ft. in 7 hours 35 min., and at another time 8873 tons in 10 hr. 2 min. At the Wesselton, from 980 ft., 8286 tons was hoisted in 10 hr. 35 min. While methods used elsewhere can hardly be transferred *en bloc* to the Rand, it does seem to be a fair question why Rand engineers do not so change their arrangements underground and at the surface as to permit full advantage to be taken of existing plant and shafts. It is true that most managers start with the mistake already made but there are mines still to be opened and it is a question whether profits would not accrue if some existing shafts were closed. The low rate of hoisting is not due to poor winding-engines. In the main these are excellent and thoroughly in keeping with the high standard of construction set by the mechanical engineers, but they are not used to capacity. The trouble is with the arrangement underground for gathering the ore and bringing it to the shaft and for this the principal responsibility rests on the men who direct the policy of the mines.

In consequence of using public money in Rand mining, it has become a settled policy to give the industry the greatest possible appearance of stability and regularity. One result is the excellent plan of developing far ahead, so as to create a large reserve of ore. Another is the insistence on uniform monthly returns. It seems to be thought that if the returns went up and down the shareholders would become unduly anxious and that an unhealthy amount of speculation would be induced. The responsible managers also fear that, however honestly they might act, the public would always believe that the grade was being manipulated with a view to the market for shares and that they were making profits out of prior knowledge. There is something in this. It is, however, by no means certain that the shareholders are as concerned about monthly returns as is thought or that, granted that they have become so, it is not largely the result of education. What the shareholders want is dividends and, unfortunately, these have been by no means as regular as the monthly returns of output. However, in practice, the greatest pains are taken to mine to the average of the ore. Formerly this was less closely done and a part only of the gold extracted was declared, the rest being placed in a secret reserve. Then it became the fashion to publish the reserve, after which there was nothing for it but to discard the practice. So that was done—nominally. Actually what happened was that the visible reserve became invisible. It retreated to the amalgam-safes, the zinc-boxes, and the stopes; it is there today and is used regularly to equalize returns. The Rand banket is by no means of uniform value. The grade varies from day to day as in other gold mines. At one mine where I examined the assay-sheets, the ore sent to the mill varied from 4 to 16 dwt. per ton. In two days it jumped from 7 to 16 dwt., and yet the manager must so arrange matters that each month checks with its predecessors at about 6.50 dwt., which is the established grade of the mine. In another property, treating ore averaging a little above 6.5 dwt., there are areas sufficiently large to supply the mill for months at an average of over 30 dwt.

The policy of working to an average grade month by month, necessarily entails keeping open a large number of stopes. It also requires frequent shifting of men and a constant re-arrangement of work underground; in the ore-house it leads to the difficulties of which mention has already been made. Perhaps it is worth the price, but it would be interesting to know exactly what the extra cost is. Approximate estimates made by men on the ground vary from 6 to 12d. per ton. It would seem entirely possible that the cost is even larger if all items be taken with account. There is also the loss of interest due to

*'Rand Metallurgical Practice,' Vol. 2, 1912.

rich ore remaining underground. There would be many advantages in adopting the policy of mining the ore as it came, so long as it was above cost in grade. For one thing, the great areas of open ground, left so that it is possible to go back and re-work stopes, are not only a potential danger from possible squeezes, but an actual one in that they interfere with effective ventilation. They are full of dust, which is stirred up by blasting. If an area could be promptly and fully worked, and then filled or closed off, conditions underground could be greatly improved.

As regards ventilation in general, the Rand mines have still a long way to go. A saturated atmosphere and temperatures up to 85° F. are destructive of efficiency, to say nothing of health, among the workers, and there are places where such conditions obtain. The mines are just beginning to be systematically ventilated but the companies have not as yet taken ventilation needs into intimate account in laying out underground work. They are about in the stage that the collieries were when they tried to work on a single-entry system, a plan long since abandoned. Having in mind the greater cost of driving in quartzite than in coal, a complete system of double entries seems out of the question, but stoppings, doors, and brattices are not, and with the wide double-track main haulage-ways it might be possible to do something effective by building a thin wall of brick between the two tracks as has been suggested by W. G. Holford.† If this were done on the main haulage advancing down the dip, it would be possible to carry fresh air direct to the lowest part of the mine in quantity. This, by decreasing the dust and reducing the temperature, would greatly improve working conditions. For the main laterals the use of a pilot-drift on the ore, connected at intervals with a haulage-drift in the foot-wall, would also carry the air. It is important in all this work to realize that large quantities of air are needed and that it must be carefully directed to the working-places if best results are to follow. Naturally any system of work that reduces the amount of ground open at one time will reduce the ventilation expense. It must be a matter of much careful consideration where to draw the line between the desirable position of having large reserves of varied grade, and of operating with the minimum working cost.

Over a period of years it is impossible to mine faster than ore is developed, and to give reasonable security for investment in plant it is customary to keep in reserve about two years ore-supply, which means loss of interest on the development-cost of that ore throughout the life of the mine to within two years of its abandonment. In the Far East mines, and also probably the deep mines of the Central Rand, the managers feel that development is being pushed at the maximum speed; every face that can be opened is kept going as fast as it can. Where this is true, the critical element is undoubtedly the fact that there is less ore per claim in the deeper ground and that where the dip is flat the amount of driving necessary to develop a ton of ore is greater. It is also much more expensive and difficult to drive at great depth because of the cumulative effect of minor hindrances. While the rate of stoping is slow on the Rand, back of that is the slow rate of development. This can only be improved by changing methods, harder driving, and other alterations which come back to modified regulations. Unless the importance of this be recognized and persistent efforts be made to effect real changes, the cost of mining on the Rand is not likely to be greatly lowered. Concentration in mining must be preceded by intensive development. In this direction the managers realize the need, but between owner, miner, and government they find progress all but blocked.

VILLAGE DEEP MINE, SHOWING OLDER TYPE OF PLANT WITH TAILING-WHEEL AND SUPERIMPOSED VATS

†Trans. Inst. M. & M., Vol. XXIV, p. 278.

In any event, and however far it may prove desirable to push concentration of mining, it is advisable to pay more attention to the main haulages and the shaft-stations so as to get greater returns from the heavy investment in shafts. How large this is and what proportion it forms of the total expenditure is indicated by figures from a number of Far East Rand mines at the end of 1915:

Mine	Shaft-sinking and equipment	Total capital expenditure
Brakpan	£407,976	£1,184,975
Geduld	193,391	1,100,000
Springs	457,497	746,000
Government areas	728,826	1,569,000
Modder B.	131,213	855,159
Modder Deep	131,523	672,000

This problem of possible concentration of work is one that warrants thorough study. On the Rand the ratio of white to colored labor is high as compared with mines elsewhere, and the contract system of directing stoping is proving unduly expensive. If concentration be feasible it is possible that labor difficulties may be lessened by substituting a large measure of direct company supervision for part at least of the contractors, and it is not impossible that the proportion of white to black labor can be made smaller.

In these and many other problems there is a conflict of interest between the engineer striving for technical success and the business manager who must keep in mind immediate as well as ultimate returns. It must also be frankly recognized that a change involves risk to the engineer as well as to the financier. If, for example, it be decided to break the ore as it comes rather than to mine always to grade, the inherent probability of a combination of circumstances leaving the mine with low-grade ore when returns are most needed, must not be overlooked. More money will be made for the shareholders in the end, provided the mine is adequately financed but if it be dependent on the share-market for capital for additional equipment the shareholders might lose as a result of a really sound policy having been followed; in any event, both engineer and manager would need to expect periods of criticism. There is a real conflict here between the claims of technology and financial policy.

It would be presumptuous in a visitor to suggest where in any case the line is best drawn. That is a matter only to be decided after much study and with intimate knowledge of the particular property involved. I would, however, urge the importance of these problems and suggest the advisability of fuller public discussion of them. The opening of the deep mines of the Rand, and particularly those in the central part of the Far East Rand, such as the Brakpan, is a real achievement in mining and this discussion will, I hope, be read more as a frank friendly raising of questions than as a criticism of current practice.

ARSENIC acid is not reduced directly by hydrogen sulphide but gives monosulphoxyarsenic acid (H_3AsO_3S) which in the presence of dilute acids gradually breaks down into arsenious acid and sulphur.

New Metallurgical Methods for Quicksilver Ores

For many years California has produced from 70 to 80% of the quicksilver of the United States. This metal is an absolute military necessity, as no substitute for it has been found in the manufacture of fulminating caps. The returns on the production of quicksilver in California for the year 1916 have practically all been received, and show an increase both in quantity and value over the previous year. The total number of flasks (of 75 lb.) amounted to 21,400 and were sold for a total of $2,000,900 by the mine operators. The quotations varied from $300 per flask in February to an average of $75 for the last 6 months of the year. Though the average of quotations for the year was $125, the actual sales by the producers averaged but $93.50. Nearly 50% of the above total came from San Benito county, about 20% from Santa Clara county, and the balance from Lake, Napa, San Luis Obispo, Monterey, Solano, and others. The California State Mining Bureau has been investigating the adaptability of water concentration, flotation with oils, and a wet method by solution with an alkaline sulphide in the treatment of mercury ores. Each of these methods has shown some ores particularly amenable to it. High recoveries were obtained by water concentration on tables with some friable ores in which the cinnabar is distinctly crystalline. In ores yielding pulp carrying a cinnabar slime, the extraction by tables is low. The slimed cinnabar can, in many cases, be economically won by flotation when there are no interfering elements in the gangue. Ochre appears to be particularly difficult to overcome, largely on account of its colloidal nature. One interesting development was the verification of information of a selective oil combination for ores carrying large amounts of pyrite. A mixture of crude wood turpentine and a crude asphaltic-base petroleum gave a higher-grade concentrate with less pyrite than any single oil used. In the hydro-metallurgical tests, using a solution of alkaline sulphide (Na_2S and NaOH) some astonishing results were obtained. On four widely different ores, assaying from 0.14 to 1.7% mercury, extractions of 86 to 97% were obtained with approximately a half-hour's contact of the solution on the pulp. On one of these ores, assaying 0.31% mercury, an extraction of 97% resulted after 15 minutes' contact. Ochre, again, is detrimental, if present in excess.

Details of these investigations will be available shortly in a bulletin on California's quicksilver resources, now being prepared by the State Mining Bureau.

LODE LOCATIONS in the counties of Gilpin, Clear Creek, Summit, and Boulder, in Colorado, are limited to 75 ft. on each side of the centre of the vein. In all other counties of the State lode claims may be taken 150 ft. on each side of the centre of the vein. The length is 1500 ft. in every case. The Federal law permits a maximum of 300 ft. on each side of the centre of the vein, and a length of 1500 ft. along the vein.

The Extralateral Right: Shall It Be Abolished?

By WILLIAM E. COLBY

*The Public Land Commission was authorized in 1879 by Act of Congress to investigate all our public land laws and propose a general revision. The Commission advocated the abolition of the extralateral right in its comprehensive report made in 1880. Assuming that it were desirable to abolish the extralateral right, this was the most favorable time to have eliminated it. The Act of 1872 had been in force only 8 years and to have wiped out the law of the apex at that time would have resulted in infinitely less hardship and readjustment than must inevitably follow if that right be abolished after the Act has been in force for nearly half a century. Since this report of the Public Land Commission was issued, the attempt to repeal this feature of the mining law has been urged at intervals. In recent years this sentiment has increased to such a degree, and the abolition of the right is now advocated by so many distinguished mining authorities and leading mining associations, that the subject demands serious consideration. Most of this agitation, however, has thus far been entirely too much engrossed with partisan condemnation of the law of the apex, while but slight consideration has been given to the principles underlying the origin and exercise of the right and those features which furnish some measure of justification for its existence; and practically no thought has been directed to the consequences which must inevitably flow from an outright repeal. These consequences would be exceedingly vital and far reaching and, unless the anti-extralateral advocates can furnish some practical solution which will minimize the mischief, the advocacy by many of them of outright repeal of the extralateral and discovery features of the mining law without a corresponding readjustment of our public land laws all along the line to meet this sweeping change, is going to produce results which will be most detrimental to the mining industry.

It is generally conceded that the fundamental principle of the extralateral right is ideal in theory. The statements of those who have analyzed the situation surrounding the occurrence of lode or vein deposits and who have pointed out the lack of any essential relation between veins or mineral deposits in depth and the overlying surface amply support the principle of severance. All that one has to do is to picture a vein dipping at an angle into the earth and visualize the result of vertical planes passed through surface boundaries cutting off the right to mine on the vein in depth at various points. Take the case where several veins dip either parallel to each other or at varying angles and realize the complex condition that would result if overlying surface-ownership controlled, and vertical planes were projected downward to chop these veins into segments of varying size and at different depths. Then conceive the ideal condition under the extralateral law where the apex-proprietor can follow a certain length of vein down indefinitely on its dip no matter where it leads. The practical result where veins are controlled by surface-ownership and chopped into segments of varying size and at varying depth is to bring about an attempt to consolidate the right to mine on the vein, and thus to sever the underground rights from the surface rights and to make them independent of one another. Only by this means can veins be most economically operated. The intent of the extralateral law was to accomplish this result in the first instance and avoid the necessity of subsequent consolidation, and hence the extralateral law is based on the fundamental conception of economic operation. But, unfortunately, though the extralateral law is ideal in theory, it is far from ideal in practical results. If veins were ideal, with regular width and dip and strike, the extralateral law would work to perfection and no one could seriously advocate change. Veins are, however, so complex in occurrence, with branches, faults, splits, junctions, and every conceivable variation in strike, dip, width, and degree of mineralization, that no matter how well the law of the extralateral right may become settled, disputes will always arise over these physical vagaries.

If we analyze the arguments advanced by those who advocate abolishing the extralateral right, we find that they practically resolve themselves into the objection based on an excessive amount of litigation. It has been assumed by most of these critics without investigation that extralateral litigation is a common occurrence and has become a burden which is seriously hampering the mining industry. Examination of the statistics leads one to believe that the situation has been exaggerated. There has been much expensive litigation, but it must also be borne in mind that, because of the magnitude of the interests involved, such mining cases attract more than their due share of public attention. Taking into consideration the immense importance of the mining industry and the fact that its operations are spread over such a vast territory in the West, the wonder is, not that there are so many extralateral cases, but that there are comparatively so few. Analysis of the law reports and tabulation of all extralateral cases appearing therein shows that during the years 1870-1916 inclusive, in all of the Western States there has been an average of less than three extralateral cases per annum which have been reported. The reported cases do not, of course, include all the extralateral cases which have arisen within this

*Abstract: California Law Review, May 1917.

period, but they do include the more important, and they afford a reliable criterion of the proportion of cases arising from year to year. The maximum was reached in the year 1902 when ten cases were reported. Since 1902 the number of reported cases has steadily decreased so that, for the past decade, excluding duplications of the same case, extralateral litigation has not averaged two reported cases a year. During the years 1908 and 1911 no extralateral cases whatever were reported. The federal extralateral decisions of the trial courts usually find their way into the reports because of their importance. The extralateral decisions in the State trial courts are not found in the reports, but these cases are of such magnitude that they often reach the State appellate courts.

It would hardly seem that the few cases arising in the entire West, especially where an industry of such magnitude and importance as that of lode-mining is involved, would justify the extravagant statements that have been made by some who urge the abolition of the right. It must be remembered that the charge of excessivce litigation is the main reason urged for repealing the law of the apex. The deductions of the writer as to the comparatively small amount of extralateral litigation which has arisen, when we consider the vast number of lode-mines being operated in the West under the extralateral law, is corroborated by an independent investigation made by Charles H. Shamel, the author of 'Mining, Mineral and Geological Law.' Proceeding along entirely different lines, he examined the syllabuses of all of the cases reported in Morrison's 'Mining Reports' which contain all the important mining decisions reported in the United States during the past half century. He arrived at the following result: "I confess that I was surprised at the actual figures. The total number of syllabuses in the 22 volumes of decisions is 5808, of which the number concerning the apex law is 115. The apex cases are only about 1.9% of the whole * * * Instead of causing 99.9% of mining litigation, as Dr. Raymond has somewhere stated, it has caused much less than its proportionate share of the trouble. Facts are stubborn things. The chief, the constantly reiterated, the convincing argument, against the apex law is based on a gross mistake as to the facts in the case."

Charles S. Thomas, a United States senator from Colorado, who, as an eminent mining attorney, is well qualified to speak on the subject of mining litigation, corroborates this view. He says: "Now the vast amount of mining controversy—and I am speaking of numbers of actions—has not been apex litigation. They have been the most expensive and the most far reaching. They have perhaps resulted in the greater proportion of injustice; but the conflicting (surface) locations have produced that multitude of cases, a small percentage of which perhaps reach the Court of Appeals, but whose aggregate has burdened the prospector and locator with an expense almost unbearable."

It is not, therefore, an excessive amount of litigation which can be legitimately charged to the extralateral right; the only valid charge on this score which can be made, is the great expense incident to such few cases as arise.

The advocates of the repeal of the law of the apex have given little consideration to the serious consequences that will inevitably result unless other features of the public-land law are simultaneously and profoundly amended. The greatest practical difficulty that will follow from abolishing the extralateral right and confining a locator to the mineral found within the vertical boundaries of his location, is the fact that only in those locations which embrace the apex of the vein can a discovery of mineral readily be made. Discovery of mineral within the boundaries of the location is the most vital essential of our existing mining law. Locations which include the apices or upper portions of the veins within their boundaries could still readily meet this important requirement of discovery, but surface locations overlying the dip of the vein at considerable distances from the apices, or upper terminal edges, of the veins could meet the discovery requirement only after the locators had expended considerable labor and time in sinking shafts to find the vein in depth. As the vein dipped farther into the earth it would be increasingly difficult to make a discovery within the vertical boundaries of the overlying locations, and finally at great depth the expense of sinking such shafts would be prohibitive. It would be necessary under existing discovery-requirements to sink vertical shafts on each surface location in order to perfect a discovery on each claim, and there would be a consequent economic waste resulting from the expense of unnecessary duplication of such shafts. Under the extralateral law as it now exists a discovery on the apex of the vein is sufficient, and the vein may be developed to great depth by a single shaft advantageously situated.

The consistent advocates of the abolition of the extralateral right cheerfully concede that this practical difficulty is serious, and they are therefore forced to urge that the discovery-requirement of the mining law be abolished also. If these two fundamental features—discovery and extralateral right—are eliminated, the system of American mining law built up as a result of years of experience and intelligence of practical pioneer miners will have been virtually emasculated. Little more than an empty shell will remain. Many critics have stated that the discovery-requirement is a feature characteristic of American mining law exclusively, and that it is a useless requirement, unnecessarily suffered by the American miner. Both statements are erroneous. The discovery-requirement is characteristic of most of the systems of mining law in the world. The elimination of the discovery feature from our law would wipe out the simplest and most practical form of test as to whether land is mineral or not.† Such elimination would destroy the simple test whereby mineral lands are now practically and easily classified under existing law so that mineral locators are able readily to defeat agricultural claimants desiring to obtain the same lands. The alternative test would be to

†'Revision of the Mining Law: Discovery,' M. & S. P., February 7, 1914.

leave such classification to an appropriate branch of the Federal Government. Even this alternative would be open to serious objection. It would substitute the opinion of mineral experts and representatives of the Federal Government as to mineral character of land in place of the views of the practical miner; it would mean aggravating delays where mines were discovered in rugged or desert regions remote from centres of travel; it would overturn a fundamental principle embodied in our mining laws by the pioneer miners, a principle which was the heritage of ages of mining experience and finally it would tear down and destroy to a large extent the great body of law that has gradually been developed with infinite patience and practical wisdom as a result of judicial interpretation operating through more than half a century. The law of discovery is now well settled and understood and to substitute for it an unknown and untried quantity would mean another period of uncertainty and litigation until a similar line of interpretative decisions had been rendered with respect to the new law. This superstructure of judicial interpretation is as important a part of the law, and is as necessary for its satisfactory working as is the organic law which it interprets. It is even more important in one sense, for the organic law may be created overnight as it were, while the interpretation and harmonizing of it, especially in its relation to other laws, takes years to accomplish.

Another practical difficulty to which the elimination of the extralateral right will give rise is that in certain of the Western States condemnation of private rights of way for mining purposes is not permissible. The courts of these States have not taken the broader view followed in other States where it is held that the public welfare is so dependent upon the mining industry that a private mining operator can exercise the right of condemnation for rights of way for mining purposes. The practical effect of the abolition of the extralateral right in those States which deny the miner such a right of condemnation would be to render him unable to operate as one mine two separated segments of the vein underlying two separated parcels of surface land where the intervening surface-owner objected. Under existing extralateral law he has the right to follow his vein on its dip irrespective of surface ownership overlying the dip. Another consequence of the elimination of the extralateral right would be to make the ownership of overlying surface all important. Under existing law the extralateral claimant frequently is willing to make a material concession to his neighbor when it comes to a dispute as to the ownership of surface on a portion of his claim. If the surface in controversy does not include any portion of the apex of the vein, the surface right frequently does not assume sufficient importance to justify litigation, and controversies are usually amicably settled, or the surface proprietor is bought out for a comparatively small sum. If the right to the vein should become entirely dependent upon surface ownership, it is obvious that surface title becomes so vital that disputes over surface would increase in number and be contested more bitterly than in the past. Practically all of the States of the West have also legislated on the subject of mining law, supplementing the laws of Congress. Most of these have embodied in their legislation the extralateral provisions of the federal statutes. While action by Congress abolishing the extralateral right would doubtless have the effect of rendering these State statutes inoperative, yet it would become necessary for each State to wipe this legislation off its statute books and harmonize its laws with the enactments Congress might see fit to substitute therefor.

These obstacles are not insuperable, but attention is called to them for the purpose of showing that the repeal of the extralateral law would be attended by far-reaching results.

Unfortunately, we cannot start anew, and we are confronted with the practical situation that during the past 67 years there have been thousands of claims located and patented under the law granting extralateral privileges with which we must reckon, for it is inconceivable that any rights already vested will be destroyed.

Two fundamentally opposed systems of mining law operating side by side, one based on the principle of severance of mineral from the surface and the other based on surface ownership carrying with it the right to everything vertically beneath, would not tend to simplification, but would inevitably add an increasing number of problems to be litigated in the courts.

The situation can be met in another way. In each State there should be a provision added to its laws whereby a judge, specially qualified to try extralateral cases, could be called in to sit where such rights are involved. To the average judge an extralateral suit is like so much Greek, and a large portion of the trial is taken up with educating the court on the elementary principles involved. In practically all foreign countries a special tribunal is established to try mining cases, and in some countries jurors, even, are required to be experienced in mining.

Another objectionable feature which can be improved, is the employment by each side of an army of experts. Practically all extralateral cases resolve themselves, sooner or later, into a battle between opposing experts. This results in great expense as well as a confusing exaggeration of structural details of minor importance. In a great majority of cases justice could be as readily obtained by a board of experts, one to be selected by each side and a third by the judge of the court, the expense to be shared equally by each party. These experts could examine the properties involved and make a report on the geological occurrences. They would agree on most facts, and where there was a difference of opinion litigation work could be ordered to further develop the points of difference. This plan would eliminate much of the expense and time consumed in such trials, and would obviate a plunge into untried hazards which are bound to follow a radical change in the law.

If it is litigation we wish to avoid, then why not also compel all locations in future to conform to legal subdivisions. Requiring lode-claims to be located in con-

formity with public-land surveys, as is now required in the case of placers, and also registering all locations in the land offices, would eliminate ten-fold as many cases as by abolishing the extralateral right; but by each of these remedies the advantage of economic operation of the ore deposit as a geological unit would be sacrificed. The vein on its dip into the earth has nothing in common with the surface, and to parcel it out by surface area and vertical boundaries is a structural misfit, and so would be the forcing of lode-locations into rectangular surface areas conforming to the public-land surveys.

Most of the mining laws of other countries recognize severance from the surface itself of minerals lying underneath the surface. The owner of the surface does not usually own the minerals lying in depth beneath his surface, but a separate property exists in these underlying minerals which the State may grant to another person. As a result there is no serious conflict between the surface owner and the individual who is entitled to work the mineral deposits beneath the surface. The law of ownership of lands acquired on the public domain of the United States, on the contrary, only recognizes such severance to a limited extent. Recent legislation by Congress does permit agricultural entry of lands valuable for coal, oil, gas, phosphates, nitrates, potash, and other non-metallic minerals. 'Known lodes' are also excepted from placers and 'known mines' from townsites. The agricultural patentee is further safe-guarded in this country by a statute of limitations, which provides "that suits to vacate and annul patents thereafter issued shall only be brought within six years after the date of issuance of the patent." Not only does this statute of limitations operate to cut off a mining claimant's opportunity to acquire mineral already known to exist in patented agricultural ground, but rulings of the Supreme Court of the United States and of various State courts have thrown additional protection around agricultural claimants, so that after their *bona fide* entry on land under non-mineral public land laws has been made, it is difficult for a mineral claimant to make a valid adverse entry on the same land.

In other words, when the United States grants non-mineral title to land there is no dual ownership contemplated except in a few limited cases. Hardship is going to result to the miner if the extralateral right is abolished without the simultaneous enactment of legislation designed to offset this difficulty. The result of an outright elimination of the extralateral right will be to feed existing agricultural patents which have veins dipping beneath them with all such extralateral segments of such veins situated vertically beneath, since such segments will fall by gravity into and become merged with the ownership of the overlying surface lands. Some may argue that this is a desirable result. It is doubtful whether the mine operator and prospector will enthuse over such an outcome. To allow minerals to pass into agricultural ownership is not going to facilitate the extraction of minerals from the soil.

The main exception in the public land law of the United States existing today which takes the place of severance in other countries, is the right of the owner of a valid lode-location embracing the apex of a vein to follow the vein extralaterally underneath adjacent surface. In other words, the extralateral feature of American mining law operates to segregate mineral deposits in the nature of lodes or veins from the surface land overlying the dip of such veins or lodes. The practical result of abolishing the right to follow a vein extralaterally and also of abolishing the discovery-requirement, would be that agricultural claimants could readily file on and enter upon land overlying the dip of the vein. Under the existing land laws there is no way to prevent such action unless the Land Department can be persuaded to withdraw the land from agricultural entry pending its classification, manifestly impossible in every instance, as well as interfering with *bona fide* acquisition of agricultural titles. With the extralateral law in force, the locator can locate a claim embracing the apex of the vein and make a valid discovery on the portion of the vein which is nearest to the surface. Abolish the extralateral right and it becomes difficult and, in many cases, impossible to discover mineral within the vertical boundaries of claims overlying the dip of the vein.

If any change is to be made in existing law, and if conditions are to be improved rather than made worse, instead of abolishing the principle of the extralateral right, it should be carried even further by amendment of the public-land laws providing for the severance from surface lands of all minerals except superficial deposits. Surface lands could be disposed of under existing laws providing for the acquisition of agricultural and other non-mineral titles except that the mineral should be permanently reserved from such surface grants. As the law now stands, and as has already been noted, only minerals known to exist at the date of the agricultural grant are reserved, and even such minerals become the property of the surface proprietor by virtue of the existing statute of limitations, and also the additional protection thrown by the courts about a surface proprietor in posession. By reserving minerals from agricultural lands, and allowing the miner the right of entry for purposes of prospecting under restrictions with the added requirement that the surface proprietor be compensated for damage, the interests of both the miner and the agriculturist would be conserved. In all the important mining countries of the world this segregation has taken place and this is the reason why in such countries the extralateral principle is not essential, whereas, in the United States, without such segregation or severance of minerals from the surface, the extralateral right has a powerful additional reason for existence. With severance of minerals and segregation of agricultural and mineral interests, the element of discovery also, now so vital in the mining law of the United States, would assume secondary importance. If the principle of severance is incorporated in a revised public-land law, a vertical boundary system for the acquisition of mineral lands could be adopted simultaneously without resulting in great hardship to the

miner, for the agricultural surface claimant could no longer claim the underlying minerals. The surface perimetre within which the miner could work should be so adjusted as to give him as much opportunity as possible to mine in depth on the vein. This would in effect be an adoption of the French system of mining law. However, a radical change of this sort would unquestionably result in increased supervision of mining operations by the Federal Government and conversely a material sacrifice of individual control over such operations. It might even result in permanent reservation by the Federal Government of all minerals, metalliferous as well as non-metalliferous, and their disposition under a leasing system. This would be in line with the new public-land policy as evidenced by recent acts of Congress and of the executive branch of the Government which have been upheld by the United States Supreme Court. The Federal Government has provided for such severance in the case of lands containing coal, oil, gas, phosphate, and similar minerals, and it may be that the experience derived from the practical development of such lands will aid in determining this serious problem when applied to the metalliferous minerals. The severance of surface title from the underground minerals would also discourage speculators and blackmailers who now fraudently seek to acquire title to surface lands under agricultural laws in order to levy tribute upon the *bona fide* mining operator.

The complex problem here presented is surrounded with profound difficulties and no matter in which direction we turn, we are confronted with unknown quantities and untried conditions. It will take a master mind to hew the way and devise a substitute law which will work in harmony with our other land laws and which will not bring chaos in its wake. It is certain that if revision is desirable it should not take place piecemeal and without due consideration of its effect on other land laws.

I feel justified in asserting that the following summarized statements are amply supported by the facts:

1. The extralateral right principle has existed in one form or another in many of the mining laws of the world but in nearly all instances this feature has been eventually abolished because of the litigation and uncertainty which it produced.

2. The extralateral right was adopted as a part of the mining law of the West by the pioneer miners when they made their earliest quartz locations in 1850 and 1851 and it became the almost universal custom and usage of the miners throughout the mining districts to exercise 'dip rights.'

3. The legislatures of practically all of the Western States and Territories had by statute declared the extralateral right to be the mining law in force in their respective jurisdictions when Congress passed the Act of 1866 which adopted and crystallized this miner's law without material alteration.

4. The Act of Congress of 1872, which is still in force, further codified and confirmed this miner-made law, changing it only in minor respects, and leaving the fundamental principle of extralateral pursuit substantially as the miners had originally adopted it.

5. The law of discovery is not only handed down to us by the pioneer miners of the West but is also a heritage of centuries of mining experience throughout the world.

6. To abolish the extralateral right will result in forcing the abolition of the principle of discovery as applied to lode mines as well, and these are two of the most vital features of our mining law.

7. With the extralateral right repealed, the only important feature of our law which has the effect of severing the underlying mineral from the surface will have been eliminated, and with the principle of discovery eradicated, the simple and practical test, now thoroughly understood, will no longer be available to the prospector and locator, and unless some substitute is furnished he will find himself at the mercy of the agricultural claimant or the unscrupulous speculator.

8. The alternative suggested of leaving classification of lands to government agents will shift the initiative in determining mineral character from the individual locator, as it exists at present, and will be a long step in the direction of complete Government control of metalliferous mining.

9. The logical solution based on world experience is to sever all mineral except superficial deposits from the surface, and dispose of the minerals and the surface separately.

10. Whether a workable system based on this principle of severance can be devised at this late day which will not result in producing greater confusion and more litigation by reason of new and untried problems and conflict with innumerable rights vested under the former system, is a question which would tax the wisdom of Solomon.

11. Revision, if attempted, must be general and not piecemeal, and should be enacted only as the result of the most careful deliberation by a commission composed of the best talent available.

Acieral, an Aluminum Alloy

An alloy containing 92 to 97% aluminum and offered as a metal of strength and lightness and non-corrosive, suitable for use in the construction of automobiles, aircraft, military equipment, railroad cars, valves, hardware, etc., has recently been put on the market. It is called acieral and is the discovery of M. de Montby. It is being supplied to the French government for the manufacture of helmets. It is silver white, has a specific gravity of 2 82 and a melting point of 1382° F. Its tensile strength in castings is given as 30,000 lb. per square inch, and in rods and sheets as 28,000 to 64,000 lb., and heat-treated as upward of 70,000 lb. per square inch. It is claimed that it may be sand-cast, die-cast with or without pressure, hot and cold forged, annealed, drawn, rolled, stamped, hardened by temper, polished, electroplated, and soldered. It withstands the action of all acids except hydrochloric.

The Pazña Tin-Mining District, Bolivia

By FRANCIS CHURCH LINCOLN

INTRODUCTION. The Pazña tin-mining district is in the department of Oruro, in west-central Bolivia, South America. It lies nearly at the geographical centre of the great Bolivian tin belt, which follows the general trend of the main range of the Andes from Carabuco near the Peruvian boundary to Portugalete not far from the Argentine border. It also lies close to the productive centre of this belt, for the two largest producers—Uncia and Llallagua—are only some 20 miles to the east; Huanuni, another of the big mines, is about 20 miles to the north; while the Aramayo Francke mines, which compete with Huanuni for third place, lie a considerable distance southward.

PROPERTIES. The following table gives the names of the principal mines and mills in the Pazña district, their owners, and the rates at which they were producing in the fall of 1916. The production is stated in short tons of concentrate (locally known as 'barrilla'), containing 60% or more of metallic tin. For comparison, it should be noted that the local unit of weight is the 'quintal,' about one-twentieth of a short ton (46 kilo), so that the figures in the table may be changed from tons to quintals by multiplying by 20.

TABLE I. PRODUCTIVE MINES OF THE PAZÑA DISTRICT

Mine	Mill	Owner	Monthly production in short tons of concentrate
Chualla Grande	Avicaya	Abelli y Compañia	60
Exaltación	Totoral	Sociedad Estañifera de Totoral Consolidada	45
Chuncho	Antequera	Nueva Compañia de Estaño de Antequera	10
Various small placers near Antequera			35
Total			150 tons

All of these properties are on Chualla Grande mountain. The Chualla Grande, Exaltación, and Chuncho mines are situated on the western, eastern, and northern slopes of the mountain, respectively. Tin has also been discovered in the southern part of the mountain, and prospecting operations are in progress there at present though as yet no production has been made. Search for ore is also being made on the flat plain, at the foot of the mountain, where numerous test-pits are being sunk on the Avicaya placer to determine its tin content.

GEOGRAPHY. Pazña is a small town with a station on the Antofagasta-Bolivia railway. It is 530 miles from Pazña southerly to the port of Antofagasta, in Chile, 45 miles northwesterly to the important Bolivian city of Oruro, and 147 more to La Paz, the principal city of Bolivia, which has railway connection to the Chilean port of Arica, and railway and steamer connection to the Peruvian port of Mollendo.

Pazña lies upon the Bolivian plateau at an elevation of 12,140 ft., just to the east of Lake Poopó, which mysteriously swallows up the waters of Lake Titicaca flowing into it through the Desaguadero river. Avicaya, where the principal mill of the district is situated, is five miles by good road north-easterly from Pazña at an altitude of 12,510 ft. The Chualla Grande mine, which

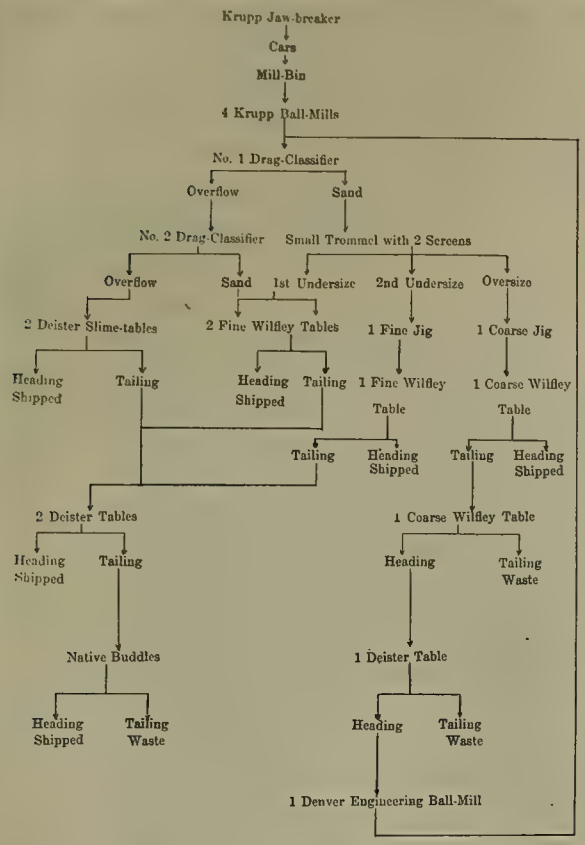
MAP OF BOLIVIA

supplies this mill, is behind the mill on the western side of the mountain near its top. It is 14,630 ft. high, the mountain being 170 ft. higher. The Totoral mill is two miles by road from Avicaya, but its Exaltación mine adjoins the Chualla Grande at the summit continuing down the eastern slope as Chualla does down the western. The Antequera mill is six miles from Avicaya by road, and the Chuncho mine, which supplies it with ore, lies on the northern slope of Chualla Grande mountain.

GEOLOGY. The topography of the region is glacial. Small cirques occupy the top of Chualla Grande mountain, and the mine is in one of these.

The country-rock of the Pazña district is quartzite,

which has been intruded by dikes of quartz-porhpyry. The quartzite beds dip westerly at from 30° to 45°. At the Chualla Grande mine there is one quartz-porphyry dike cutting a lode in depth, and another intrusive in a lode in much the same manner as that at the Concordia mine in the Quimsa Cruz district described in a previous article.* The geology of the Exaltación mine in the Pazña district has been outlined by Rumbold† who



FLOW-SHEET OF AVICAYA TIN-CONCENTRATING MILL

makes brief mention of the other mines of the district; and a few notes on the district, mainly mineralogical, have been given by Romaña.‡

At the Chualla Grande mine there are seven important veins, which, in order from east to west, are the Almacen, Dique, Carmen, San Francisco, San Luis, Parada, and Hospital. These veins roughly follow the bedding of the quartzite, but, after the manner of many Bolivian tin lodes, they show a tendency to join and branch both in dip and strike and thus to form a linked-vein system. They vary in width from 3 to 30 ft. and have been explored to a depth of 585 ft. Farther to the westward and at a lower elevation, the Minchin adit has cut numerous narrow tin-bearing lodes.

The ore-shoots are generally widest near their outcrops, decreasing in width with distance from the surface both laterally and in depth, although the mineralized beds may retain their surficial widths. The oxidized ore is also, as a rule, the richest, the sulphide ore being not only narrower but also poorer in tin. The primary ore consists mainly of cassiterite, pyrite, and quartz, with minor amounts of tourmaline and occasional chalcopyrite. In the oxidized zone the pyrite has been altered to iron oxides. Discussing a thin section of the ore as seen under a microscope, Romaña says that "together with the quartz a little orthoclase has also been deposited, and it appears that there are some crystals of corundum," but these minerals have not been recognized with the naked eye. Higher than the tin lodes, on either side of the highest peak of Chualla Grande mountain, stringers of wolframite an inch wide have been found, but it has not yet been observed in the tin-bearing veins.

MINING. The Chualla Grande mine is owned by Abelli & Co., Mr. Abelli having recently taken up his residence in the United States. M. F. Grondijs is consulting engineer, Ernst Schrenberg is manager, Ladislas Jackowski mine-superintendent, and Pablo Hahn mill-superintendent.

Miners receive from 2.80 to 3.20 *bolivianos* per day, which at present rates of exchange is $0.93 to $1.07. Helpers get 2.20 to 2.40 *bolivianos*, or $0.73 to $0.80. Both rock and ore are extremely hard, so the cost of mining is high for Bolivia.

The Almacen, Carmen, San Francisco, and San Luis veins are now being worked, and the Minchin adit is being driven toward the Ballivián shaft. This adit was started at an elevation 920 ft. lower than that of the little plaza just below the main workings. The shaft is farther west, and as the veins dip to westward with the slope of the mountain, its collar is but 770 ft. above the level of the adit. The shaft has a depth of 585 ft. and thus lacks 185 ft. of reaching the adit-level; while the adit, which already is about 3000 ft. long, has yet over 400 ft. to go to reach the projected shaft.

Machine-drilling proved impracticable in the adit, because the heavy blows struck by the big drills against the very hard rock necessitated an excessive expenditure for repairs, and the adit is now being driven by hand at a rate of only 13 ft. per month. The cost of driving has at times reached $17.20 per foot. Four stopers and two jack-hammers are at present employed in the mine, but the use of column-drills has been discontinued.

MILLING. The Avicaya mill is now being remodeled and is only treating some 25 tons of tin ore per day, but when the changes in progress have been completed it is expected that it will have a daily capacity of 50 tons. The ore is said to average about 5% metallic tin and the tailing to run under 1%.

The ore is brought to the mill by aerial tramway. It passes first through a Krupp jaw-breaker and is then trammed by hand to a bin. From this bin, it at present goes to four Krupp ball-mills, but two 5-stamp batteries are being installed to replace these. The remainder of the concentrating process is shown in the flow-sheet.

*M. & S. P., Vol. 110 (1915), p. 722.

†*Economic Geology*, Vol. IV (1909), p. 351.

‡Boletin del Cuerpo de Ingenieros de Minas del Perú, No. 57, (1908).

Concentrates

Readers of the MINING and Scientific PRESS are invited to ask questions and give information dealing with technical and other matters pertaining to the practice of mining, milling, and smelting.

BLOWPIPING, in the determination of minerals, is more readily done with the flame of an ordinary candle than with either gas, alcohol, or oil, in the hands of a skilful operator. Most expert blowpipers prefer the candle-flame, using a hard adamantine stearic-wax candle. It is possible to manipulate the flame so skilfully as to oxidize a borax bead, containing a copper-test, at one end, and to reduce it at the other, so that one part of the bead will be blue and the other will show the red metallic copper.

CHROMIUM may be detected, even when present in minute quantities, by fusing the suspected substance on charcoal with sodium carbonate. If much chromium be present the resultant slag will have a greenish color. Pulverize the slag and dissolve it in water. Acidify the solution with acetic acid, and add a few drops of a solution of silver nitrate. A reddish brown precipitate of silver chromate will be thrown down. The reaction is so delicate that mere traces of chromium will thus be shown.

QUOTATIONS on certain ores and metallic products, such as antimony, chrome, manganese, and tungsten, are based on the unit. A unit is one per cent; therefore, when the short ton (2000 lb.) is used, the unit is 20 lb., but when sales are effected on the basis of the long ton (2240 lb.) the unit is 22.4 lb. In the case of manganese, settlements are made on the long ton, where the unit is 22.4 lb. of the metal, but tungsten is sold on the short-ton basis, and the quotations refer to the unit of 20 lb. of the contained tri-oxide, WO_3.

THE EXTRA-SOLUTION employed in the Russell process of lixiviating silver ores by a solution of sodium-hypo-sulphite was made by mixing in solution two parts of the hypo-salt with one of copper sulphate, the result being a double salt known as copper-hyposulphite. It is claimed to have a solvent power nine times as great as the ordinary hypo solution, and was used successfully in treating some refractory silver ores. The method was described in great detail by Ellsworth Daggett in the Transactions of the American Institute of Mining Engineers.

IODINE is frequently associated with phosphates in sufficient quantity to be worth extracting. The method of Thiercelin, a French chemist, for accomplishing this consists in treating the phosphate with equal quantities of sulphuric acid and water in a tank provided with means for agitation. The reaction proceeds under the influence of the heat generated during the dilution of the sulphuric acid, and the iodine is liberated in the form of vapor, which is condensed in a suitable chamber. A modification of this method consists in leaching the alkaline iodide and electrolyzing the filtrate, using a carbon anode and an iron cathode. The iodine is liberated at the anode, is collected, washed with cold water, and dried in a current of heated air.

FROST-RESISTANCE of building-stones may be tested by soaking the stone in a solution of sodium sulphate, and allowing it to dry. The expansion of the crystals in the pores of the rock exert a pressure greater than frozen water, so that the test is particularly severe. A stone that will not scale off badly under this treatment may be considered to be highly frost-resistant. A good sand-stone tested in this manner should show a loss in weight not exceeding 50 to 60 parts in 10,000; a granite should not exceed 8 to 15 parts, and a marble not more than 15 to 20.

TRAPICHE is a Chilean application of the word by which a cane-mill is commonly designated throughout the sugar-growing countries of Spanish America. In this special use, which is also noted in Mexico, it signifies a type of Chilean mill which consists of a beam, at one end of which a revolving wheel-stone is fixed so as to turn as upon an axle, a pivot being provided on the beam not far from the stone, while the longer end extends beyond the circular grinding-pavement so as to gain the advantage of considerable leverage, thus enabling a mule to revolve the stone.

FIXATION of nitrogen with manganese has been investigated by Haber, the inventor of the now famous Haber process of combining nitrogen directly with nascent hydrogen. Finely divided metallic manganese is heated to redness in a stream of nitrogen. The result is the formation of pentamangandinitride, Mn_5N_2. Haber, however, suspects that the nitro-manganous substance formed may possibly consist of Mn_3N_2, associated with oxides of manganese, which seems most probable. It possesses a dull metallic lustre, and is feebly magnetic. On being treated with water and alkalies it yields ammonia.

CHLORIDIZING of copper, by treating cinder from cupriferous pyrite with common salt, yields cupric chloride, $CuCl_2$, which is soluble in water. For a successful chloridizing roast the ore and salt must be finely divided and intimately mixed, there must be free access of air, and the charge must be vigorously rabbled. The amount of sulphur present should equal that of the copper. The temperature at which the operation is conducted should not exceed 600° C., and 500° C. is sufficient to promote the reactions. Hot water extracts about 75 to 85% of the copper present, yielding a metal of great purity. The remaining copper is extracted by a first treatment with 'tower-liquor,' an impure acid-liquor obtained by passing the roast-gases through a quartz-filled tower through which water trickles. In this the larger part of the copper, not previously taken out by the water, is dissolved. A final treatment with 8° Baumé sulphuric acid for 2 to 3 days extracts the greater part of the residual copper.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

OATMAN, ARIZONA

THE NEW TOM REED MILL COMPLETED.—A RADICAL CHANGE IN METALLURGICAL METHODS.—IMPORTANT DEVELOPMENT OF OTHER PROPERTY OWNED BY THE BIG JIM COMPANY.

May 25 was the date officially fixed by superintendent Edward M. Rabb as the time when the 20-stamp mill of the Tom Reed company will be shut down permanently and the new 300-ton Allis-Chalmers ball-granulators will begin the fine crushing of the ore for cyanidation. It will be ten years, almost to a day, since the first 10 stamps of the Tom Reed company were set in motion. During that time the company has milled a little over 300,000 tons of ore from which $6,350,000 in bullion was extracted, and $2,750,000 in dividends paid.

THE NEW TOM REED MILL, OATMAN, ARIZONA

The new mill will have double the capacity of the old one. After the initial crushing, the ore is conveyed to a 300-ton ore-bin from which it is fed into the 5 by 6-ft. Allis-Chalmers ball-granulator by the Reeves and Stephenson-Adams machine. The product from the granulator goes to a Dorr duplex-classifier.

The undersize from the classifier goes to a primary Dorr thickener and the oversize will feed into two 5 by 6-ft. Allis-Chalmers fine ball-granulators. Two Dorr duplex-classifiers will operate in closed circuit with these ball-mills.

The overflow from the primary thickener will flow to a gold sump-tank of steel. This solution will be clarified by a Butters filter, connected to a Gould vacuum-pump and discharging into a redwood tank.

To the clarified solution from this tank will be added the emulsified zinc-dust from a Merrill zinc-feeder and then elevated 35 ft. by two Rumsey triplex-pumps and forced through two 300-ton Merrill precipitating-presses. The precipitated solution from the presses flows by gravity to a barren-solution storage-tank, the solution from this tank passing by gravity to the decantation-tanks, thus entering the mill-circuit again. The precipitating-press room together with the melting-plant and roasting-furnace, will be situated at the top of the mill.

The underflow of pulp from the primary thickener will pass through four 12 by 40-ft. redwood tanks fitted with Dorr agitating-machinery. From the agitators the pulp will be divided into two streams, each stream passing through a battery of four steel Dorr thickeners to counter-current decantation-tanks.

A Leschen aerial-tramway is being constructed, having a capacity for delivering 300 tons of ore daily from the Aztec shaft to the mill. This tramway will be 4000 ft. long. It is expected to be in operation about June 15.

It is the plan of the management to take ore for the new mill from the Aztec shaft where the vein has been opened up by driving on both the 400 and the 535-ft. levels.

This will afford an opportunity to open up the 1400-ft. level at the Ben Harrison workings of the company from which practically all the ore milled during the past ten years has been taken. The main shaft will be extended down to the 1400-ft. level, which is now reached only by a winze.

The annual report of the company now being sent to the stockholders shows ore reserves of 54,000 tons in the old workings, not counting any of the ore recently developed in the Aztec claims. About 46,000 tons of ore was milled during the past year averaging $11.03 in gold, which cost $6.48 per ton to mine and mill. Over $200,000 has been expended during the year in development and in constructing the new mill. A net profit of $131,000 was returned from the year's operations.

MAGDALENA, NEW MEXICO

LEAD-ZINC MINES ACTIVE.—THE EMPIRE ZINC COMPANY EXPANDING.—VALUABLE DISCOVERY OF ASBESTOS.

At Kelly, the mining district about three miles from Magdalena, a period of great prosperity has set in. More men are being employed now than at any time in the past. Many new improvements have been made in the district during the past few months, and large sums have been expended by the companies in putting the works in good condition. The Empire Zinc Co. is re-opening and re-timbering a new shaft, which was sunk last season from the tenth level to a depth of 108 ft. The work was stopped before on account of water, which made it necessary to abandon the project for a time. The ground caves badly and cannot be held by ordinary means. The present effort, however, is meeting with success. It is intended to sink to a depth of 300 ft. to get under a large body of ore. The ore is said to run high in zinc and copper. The company is considering the construction of an aerial tramway from its Lynchburg mine to the mill. The smelter, which was destroyed by fire last year, has been re-built and greatly improved. A large number of men are employed at that plant.

A large number of natives of Mexico are employed in the mines of the Magdalena district, and, contrary to the fears of many, and the frequent rumors of the seditious intentions of the aliens, the miners have been found to be, in the main, a peaceable lot and unaffected by the outbreak of hostilities between the United States and Germany.

A discovery which is interesting a number of people in this district is asbestos in the vicinity of Reserve, a small settlement in the western part of the county. Fine specimens were picked up by J. C. Smith, of Magdalena, who chanced to observe it while passing. The outlook is sufficiently promising to warrant the sinking of a shaft, which is now being done. H. Mangold, of Oregon, who is experienced in asbestos, has reported favorably upon the find. Villages are springing up between Magdalena and Kelly, making it probable that in a few years there will be one large town to take the place of the several scattered camps, if the increasing prosperity of the mining industry here continues.

LEADVILLE, COLORADO

DEVELOPMENT OF THE MIKADO MINE BY THE IRON SILVER COMPANY.—NEW MACHINERY EQUIPMENT.—PROSPECT OF LARGE PRODUCTION.

With the recent completion of its plant at the Mikado shaft, on Iron hill overlooking Stray Horse gulch, the Iron Silver Mining Co. has perfected the most substantial and modernly equipped property now operating in the Leadville district. The construction of this plant has required more than a year of continuous labor under the direction of George O. Argall, manager, and Ralph Poole, superintendent. The expenditure reaches nearly a half million dollars. The project was undertaken early last year when the Iron Silver Co. secured control of the Mikado, R. A. M., Pyrenese, and other surrounding properties located in the centre of the Graham Park basin; and completed plans for draining this area through the Mikado shaft. Pumping equipment for the enterprise was ordered in April a year ago, and at that time the work of preparing the shaft for unwatering and erecting a surface-plant was started. The task of replacing the old plant at the Mikado with the present substantial and up-to-date equipment, and of draining and re-timbering the shaft has been a big one, and its successful accomplishment is an evidence to the knowledge and able management of the men who have had charge of the work. The re-timbering of the shaft from the collar to the water-level, which, at that time, stood at a depth of 912 ft., was first undertaken employing the old machinery and plant. This work was rushed in order that the shaft might be in condition to receive the heavy pumping-equipment which had been ordered for 90-day delivery. This haste, however, was unnecessary, for after repeated delays in shipment the machinery did not arrive until April of the present year. While re-timbering was under way, the construction of a new surface-plant was in progress. A 40 by 80-ft. structure was built and divided into two 40 by 40-ft. rooms for housing the machine and blacksmith-shops, and a 35-ft. head-frame of Oregon fir was erected over the shaft. At this stage, the shaft work was completed to the water-level, and the old engine-room, head-frame, and old hoist were removed. This done, concrete foundations for the new hoisting-machinery were laid and construction was started on the new engine-room, office, store-room, and the housing over the shaft.

These buildings have been equipped with the finest plant of electrically driven machinery in the district. A Wellman-Seaver-Morgan double-drum hoist—the largest power-hoist in the district—driven by a 300-hp. motor has been installed in the engine-room, together with an Ingresoll-Rand air-compressor of 1080 cu. ft. capacity driven by a 200-hp. motor. The hoist is equipped with a Welsh safety-device and the compressor with an automatic-unloader. The machine-shop is completely equipped with power-driven machinery, including a lathe, drill-press, pipe-cutter, bolt-cutter, hack-saw, emery-wheels, grind-stone, and other appliances necessary to the upkeep of the plant. In the blacksmith-shop, a large air-hammer, shearing-machines, drill-sharpener, and chain-blocks are installed. The office is modern, and the store-room has every facility for taking care of supplies. The housing over the shaft is a two-story structure to accommodate two hoisting decks. It is steam-heated and contains a commodious room where the men change their clothing and eat their lunch.

A large transformer-house of structural-steel frame and sheet-iron covering has also been erected and equipped with transformers. A repair-pit of concrete has been built-in to facilitate overhauling the transformers. An aluminum-cell lightning-arrester is also installed in the transformer-house, and the power-load consumed is registered by a polyphase watthour metre.

At the present time, the boiler that supplies steam-heat for the plant, is installed in an old building. This, however, is to be removed, and the boiler will be placed in a new ore-house that is to be erected.

Surface-lighting is provided by three 500-watt searchlights which have been installed at advantageous points by the Colorado Power Company.

Underground progress has been made with the installation of pumping-equipment, draining, and re-timbering the shaft. Since the heavy pumping-machinery for the project was ordered last year, draining has been through the Wolftone and Greenback properties adjoining the Mikado. The latter shaft is 1350 ft. deep, and the pumping there has materially decreased the flow in the Mikado, making it unnecessary to install the complete draining-plant. At the 900-ft. level, a new station has been cut, and one of the two station-pumps ordered has been installed. These machines are six-stage horizontal centrifugal-pumps driven by 500-hp. motors and are capable of lifting 1000 gal. per minute under a 1200-ft. head. They were manufactured by the Worthington company. Drainage of the shaft is being performed by a small air-sinker that handles about 40,000 gal. every 24 hours. It discharges into a reservoir on the 900-ft. level. This reservoir has a capacity of 25,000 gal. and is emptied twice daily by the centrifugal station-pump. Two sinking-pumps of the four-stage vertical centrifugal type with a capacity of 1000 gal. under a lift of 350 ft. are stored at the property ready to be installed when needed.

Re-timbering in the shaft below the 900-ft. level is still in progress but is rapidly being completed to the bottom at a depth of 1200 ft. This task has been a most difficult one from the beginning. The Mikado is the largest shaft in the district being 5 by 15 ft. in the clear and divided into three compartments. From the collar down to a depth of 100 ft. it was neces-

sary to crib the shaft. Below that point square-sets of Douglas fir have been used. From the 900-ft. level to the bottom, the shaft originally had only two compartments. From that point to a depth of 1070 ft., where the work is now under way, it has been necessary to cut a new compartment and remove one foot of rock on each of the other three sides before timbering, so that progress has been comparatively slow. Protection to the shaft has been provided by the erection of two sheet-iron doors in the hoisting-compartment just above the point of operations.

One compartment which has been devoted to the accommodation of the water-column and power-cables, has been divided into two sections. In one of these, a small service-cage will be installed and handled on a steam-winch to take care of the hoisting and lowering of men and supplies. It will take the place of a ladder-way and give more rapid service and at the same time leave the two main compartments free for hoisting ore and waste.

On the 1000-ft. level, the work of re-opening the old drift is in progress and will be pushed ahead to the large orebodies known to exist in that part of the property.

The shaft is equipped with an electric-bell signal-system, and mine-telephones are being installed at the two levels now open.

The Iron Silver Mining Co. is one of the oldest operators in the Leadville district, having been engaged in the development of the Moyers, Iron Mine, and Tucson properties for a number of years. Operations are still in progress at these mines, but the centre of activity has been changed from the Moyers, in California gulch, to the Mikado which will be the heavy producer of the group in the future. The company's offices have been moved from Oro, near the Moyers, to the Bank Annex building, in Leadville.

MANHATTAN, NEVADA

NEW DEVELOPMENTS OF IMPORTANCE.—HIGH-GRADE ORE IN SEVERAL MINES OF THE DISTRICT.—SHAFT SINKING PROGRESSING.—COMPANIES BEING FINANCED SUBSTANTIALLY.

The important event of the week in mining development in the Manhattan district has been the strike of high-grade ore in the Train-Chase lease on Mustang hill. At an approximate depth of 200 ft., in the bottom of two winzes sunk from the main workings, stringers of rich ore, which were being followed, have opened up from one to two feet into lenses that carry from $100 to $200 per ton in free gold, with sulphides averaging as much more. The lessees are bringing to the surface about $1000 in each shift's work. While the Train-Chase lease has been a consistent producer from the grass-roots to the present depth of 200 ft., having produced over $35,000, present indications point to a much heavier production. The fact that the present developments show heavy sulphide ore in the winze bottoms, is important, and is thought to indicate that the primary ore-horizon has been reached. The lessees expect that at any time the winze-sinking operations may break into a large and rich orebody, and a mine similar to the White Caps, developed.

In addition to the high-grade ore being produced from the two winzes, a raise is being extended on a third ore-chimney about 40 ft. east of the winze ore-pipes. This raise has been cut to a height of 35 ft. above the level, and the entire face is in ore which will average $100 per ton. The last 15 ft. in the raise has produced ore of similar grade.

The Doris mine, although north of the main producers in the district, has an attractive showing, with a well-defined porphyry dike. The property is being operated on company account, and during the past few days the value of the ore has shown a marked increase.

The Union No. 9 claim of the Dexter company is showing well through the operations of lessees. The Juhl-Fogle lease is sinking on the same grade of ore as that of its first shipment, running over $80 per ton in the mill. The lessees' shaft is down over 100 ft., and although the seeping of surface-water into the shaft necessitated considerable bailing and delayed mining operations to some extent, the flow of water has ceased and shaft-sinking has been resumed. The lease is operating on a new vein—a cross-fissure, almost vertical. Two more lease-blocks have recently been granted by the company and similar cross-fissures are being developed.

The company working-shaft of the Extension is down 100 ft. and driving on a cross-vein is progressing. This vein is at right-angles to the limestone-belt that carries the orebodies and is in the foot-wall shale.

The shaft of the Red Top is down 85 ft., and is in broken limestone, having passed through the shale. The screenings from this limestone carry gold, indicating the proximity of the orebodies to reach which the work is being done. As the shaft is being sunk by hand-work, the company not having yet installed a compressor for operating machine-drills, the footage made each day is small.

Although some delay has been experienced in driving east from the 600-ft. level of the Amalgamated, due to a heavy flow of water, still 16 ft. has been added to the length of the drift within the week. The total length for the east drift is now 184 ft. This is about half way from the company shaft to the Earl orebodies, for which the east drift is being extended. The face of the drift is in low-grade ore which is increasing in value as the face of the drift advances. The fissure vein is showing good ore. A raise on the west orebody has been started, 40 ft. having been made on ore running $25 to $40 per ton. The company mill has been running during the week.

The work in the Consolidated during the week has been devoted to cross-cutting from the shaft, 40 ft. having been made through a black lime-shale, which forms the hanging wall of the vein in the upper levels of the mine. The lateral work is proceeding and the only delay possible will be caused from a heavy flow of water from the vein itself. The large Cameron sinking-pump is prepared for such an emergency. In addition to the sinker there is a Deming 4 by 6-in. triplex electrically-driven station-pump ready to install on the level should the flow of water remain constant. The past few feet of the cross-cut has shown numerous calcite stringers which may be taken as a sign that the orebody is near. The conditions in the face of the cross-cut are identical with the hanging wall of the vein as they appeared in the Consolidated upper levels, adjacent to the ore.

The working-shaft of the Morning Glory has reached a depth of 80 ft. Steady work with two shifts has been the rule. The shaft is on the lime and shale contact, west of the White Caps west orebody. The gouge upon which the shaft is being sunk, carries gold. As depth is gained the value of the ore has shown a gradual increase. With a few more feet of depth, upon reaching the point where the orebodies in the lime-belt are expected to be found, the contact should show ore of milling grade.

The company has sent out notices calling for a special stockholders meeting, to be held on May 25, at its Tonopah office. The purpose of the meeting is to increase the capital stock to a million and a half from a million shares as at present capitalized.

The subscription list for the selling of sufficient shares from the treasury of the White Caps Extension Mining Co. to provide funds for operations, has been filled, as the stock was over-subscribed within three days after it was offered for sale. Preliminary surface work has been started by the company. The management has considered the advisability of sinking shafts, although the plans are tentative. The points where these shafts will be sunk has not been decided.

The operations at the White Caps show steady work both in mine and mill. The shaft has reached a point 45 ft. below the fourth level, with the shaft-timbers all in place. So far, little water has been encountered in the shaft. On the third

level 30 ft. was made during the week, with the face of the drift in oxidized and mineral-stained material, indicating that the contact is being approached. In the west drift, the early part of the week was devoted to allowing seepage water to drain out of the country opened by the drift. In the face of the drift, the ground apparently is out of the faulted zone. The limestone drag carries $12 in gold. In the mill the roaster-column, shell, and doors are in place. The machinery in the sand-tank building is all in place with tanks, piping, and pumps installed and ready for operation. The mine ore-bin, of 200-ton capacity, is in process of erection and should be finished before the week's end. The excavation and masonry for the installation of the coarse crusher has been finished, and the crusher can be installed at any time; the large belt-conveyor structure is also nearing completion. The new wagon-road, to connect with the Tonopah-Manhattan county-road at Pipe springs, has had 20 men employed steadily during the week.

COBALT, ONTARIO

THE LABOR TROUBLES BECOMING MORE THREATENING.—THE MINE-WORKERS MAKE A FORMAL DEMAND.—A GOVERNMENT COMMISSION EXPECTED TO HANDLE AN ACUTE SITUATION.

Affairs in mining have been comparatively quiet of late, ore and bullion shipments for the second week of May being considerably below average. However, one pleasing feature was the report for April of the Kerr Lake Mining Co. in which it was shown that over 250,000 oz. of silver bullion was recovered, a record in the history of this mine. This company only recently subscribed $300,000 to the United States Government Liberty Loan.

Nipissing continues to be the leader and during April mined ore of an estimated value of $259,082, in addition to which $517,719 in bullion was shipped from the Nipissing customs-plant. The manager reports nothing unusual in connection with development except that operations were satisfactory. Perhaps the most talked of topic on the street is the labor situation, and although wild rumors are heard from time to time, it is generally believed by those who are in close touch with both the mine-workers and the managers that a settlement will ultimately be brought about. Tuesday morning, officials of the Miners' Union mailed a letter to each of the various mine managers of the different camps, including Cobalt, Porcupine, Kirkland Lake, and Gowganda. The letter contained a copy of the wage-scale that has been adopted by the Union, together with a request that a conference between mine-workers and managers be held, and also requesting that a reply be forthcoming by May 31. Several of the managers have openly stated that they will refuse to acknowledge the receipt of the communication, in view of which it is probable the situation will early in June grow more tense. It is considered probable, however, that either before or about that time, a commission will have been sent to Cobalt and Porcupine for the purpose of looking into the situation, and that the commission, acting independently of either mine managers or mine-workers, will adjust all differences.

PORCUPINE AND KIRKLAND LAKE

LABORS DEMANDS THREATEN TO CUT HEAVILY INTO THE PROFITS OF IMPORTANT MINES.—KIRKLAND LAKE MAKES A GRATIFYING DISCOVERY.

In Porcupine, there is nothing taking place that would indicate a serious curtailment of operations except at the Dome Mines. It is generally regretted that even a moderate restriction of operations at the Dome should occur, but on the other hand, such a development will have the effect of releasing labor, thereby adding to the supply at other properties. The McIntyre-Porcupine is, perhaps, in the most enviable position of all the Porcupine mines, in that mill-heads, at around $11 to the ton, are sufficiently high to allow for a compliance with what the mine-workers have demanded and also to pay the increased cost of supplies and still to show a large margin of profit. At the Dome Mines where mill-heads maintain at a little less than $5 per ton, it is a difficult problem to hold costs down to a point where anything like an attractive profit could be shown. On the other hand, the Hollinger with $8 ore could meet the increased burden and still show handsome returns. The Schumacher mine with $6 ore is in a position somewhat similar to the Dome, while the Porcupine Crown and Porcupine V. N. T., both of which are treating upward of 100 tons of ore daily, with mill-heads at $10 or more per ton, could also bear the burden of increased wages to their workers.

The work on vein No. 58, at the Hollinger, continues to attract attention, a large tonnage of high-grade ore having been developed at the 425-ft. level. Developments in other parts of the mine are adding daily to the large ore reserves. Although diamond-drilling from the 1000-ft. level of the McIntyre has been going on for some time, there has been no official announcement as to whether this vein extends into McIntyre property or not.

In January about 1300 men were employed at the Hollinger, the number is now scarcely over 900, which is an index of the heavy falling off in available labor in Ontario.

In the Kirkland Lake district there is much activity, the most important development being at the 600-ft. level of the Kirkland Lake Gold mine. A short time ago the vein at this depth was reported to have been proved to be 27 ft. wide. According to advice received here, a small horse of country-rock was cross-cut and the vein is now said to be 46 ft. wide. This property is under option to the Beaver Consolidated Co. of Cobalt, the total purchase price being approximately $308,000. The first payment of $75,000 was made early in the year, and the second payment of a like amount is due May 22. This payment, it is understood, will be made promptly. The new mill at the Teck-Hughes is treating about 50 tons of ore per day, and mill-heads are around $10 to the ton. The Tough-Oakes is recovering in the neighborhood of $70,000 in bullion per month, and the current year will probably be the most productive in the history of this mine. The installation of a new mill at the Lake Shore is proceeding.

CRIPPLE CREEK, COLORADO

AN IMPORTANT SURFACE DISCOVERY ON BEACON HILL.—LESSEES DEVELOPING AND BREAKING PROFITABLE ORE.

A promising surface discovery has been made by Thomas Keating on the north end of the property of the Albert-Beacon Mines Co., on the south-east slope of Beacon hill. Ore valued at $40 per ton was exposed and mined at a depth of 15 ft. and the first shipment of 30 tons was loaded out by team last week.

Operations were resumed at the Rex mill on the southern slope of Ironclad hill by Thomas Kavanaugh, a well-known operator, who is working the property under lease.

The low-grade ore of a value between $2 and $3 per ton is being mined from the big open-cut on the Magna Charta claim, and Kavanaugh is treating this ore at a profit. The mill and Magna Charta claims are owned by the Rex Gold Mining & Milling Company.

Hahnewald Bros., lessees and operators, are sinking the Jackson shaft of the Gold Soverign Mining & Tunnel Co. Stoping is at a standstill until the shaft has reached a depth of 1500 feet.

The Dante mine resumed operations on May 19, in charge of Mr. Johnson, the superintendent, representing Denver lessee-operators. Four sets of sub-lessees are breaking ore and shipments will be shortly resumed. The Dante Bull Hill mine has a production record of $1,120,951 gross to date.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

The Golden Gate 10-stamp mill, on Chichagoff island, is reported to be in operation again. It was shut-down for several months during mid-winter owing to a shortage of water, which is taken from a lake, but the pipe-line became clogged with a mud-slide. The débris having been removed, the mill now has an abundant and continuous water-supply.

ARIZONA

(Special Correspondence.)—Arizona copper production this month is going at the rate of better than 75,000,000 lb. All the smelters have been loaded down with ore during the month, the mines being more than equal to the higher rate of output. In consequence the mines have diverted considerable labor from production to development and are crowding it. The Calumet & Arizona's reputation for speed has been given another advance by the attainment of 68 ft. of sinking in its four-compartment shaft on the Gadsden in the Jerome district, in one week. The equipment of this property is the largest ever placed on a prospect in Arizona.

Bisbee, May 18.

Pima County

(Special Correspondence.)—The New Cornelia Copper Co. will be outputting copper, ready for delivery to the consumer from its plant at Ajo, early in June, a month ahead of the time fixed when plant-construction was commenced.

Ajo, May 18.

Yavapai County

(Special Correspondence.)—The United Verde Extension is to have an ore-haulage adit in service by June 15, 1918. It will be 13,500 ft. long and will cost approximately $500,000. It will give the Jerome district its second great haulage tunnel, that of United Verde being in successful operation from the 1000-ft. level, receiving ore from both above and below that depth. The Extension adit will connect with the 1300-ft. level of that mine.

Jerome, May 18.

On Thursday, May 24, miners working in the large copper producers of the Jerome district went on strike, demanding higher pay. It is said the strike was instigated and is being directed by the International Union of Mine, Mill, and Smelter Workers. On Saturday, May 26, the sheriff and 25 deputies were in charge at the United Verde mine, and up to that time there had been no disorder. The union men, according to press dispatches, claim that every mine in the district, except the United Verde and United Verde Extension is closed, and that 80% of the men employed in the two mines mentioned are also out.

A press dispatch from Phoenix, dated May 28, states that a mob of strikers is dragging workmen who refused to join the strikers, through the streets, and some of the men have been seriously injured. It is said the local authorities are unable to handle the unruly element. There are several hundred strikers parading the streets and threatening the destruction of property. Governor Campbell and Col. J. J. Hornbruck, who have been directed by the War Department to preserve order in the district, have gone to Jerome. John McBride, former president of the American Federation of Labor, who has been appointed to act as conciliator by Secretary of Labor Wilson is now at Jerome. The city council of Jerome has forbidden women and children to go upon the streets in the business district. There is much interest in the progress of this strike in a prohibition State, being the first important strike that has taken place in the mines where it is supposed that it will be impossible for the strikers to obtain liquor.

ARKANSAS

Newton County

The old Confederate mine, on Haw branch of Cane creek, is again in operation after many years of idleness, and a concentrating-mill with a daily capacity of 350 tons is being built. The old workings are being cleaned out and extended and preparations are being made for a large and steady production. It was here during the Civil War that the Confederates obtained a large amount of lead which was cast into bullets. There is also current a story to the effect that a great deal of saltpetre was obtained from caves along Cane creek, a small stream 16 miles long. The nitre was refined on the spot by boiling the crude mineral in large kettles and then evaporating the liquor after filtering.

CALIFORNIA

The petroleum industry of California is expanding constantly. Reports filed with the State Mining Bureau for the week ended May 19, show 29 new wells started, making a total of 433 since the first of the year, 17 wells ready for test of water shut-off, 9 deepening or re-drilling, and 3 wells abandoned.

Calaveras County

(Special Correspondence.)—The Hexter drift mine, on Stockton ridge, a mile and a half from Mokelumne Hill, has 1000 ft. of the channel opened, and the company, the Stockton Ridge Consolidated Mining Co., is only awaiting the arrival of its engineers to begin work. H. S. Chapman is superintendent.

The Buffalo gravel mine, in Chile gulch, a mile from here, is about to resume operations. They have been shut-down owing to delay in getting machinery from San Francisco. The mine has a record as a profitable producer in the past.

In Happy Valley, the Emerson mine is being prospected by W. H. Morrison and associates of Stockton. They are experimenting with a machine designed to save the fine gold in the gravel. The mine was at one time worked by hydraulic method and was profitable, but with the many others was shut-down when hydraulic mining was inhibited, nearly 40 years ago.

Mokelumne Hill, May 18.

(Special Correspondence.)—It is reported that the Blazing Star mine, a mile from West Point, is being negotiated. This report has not been confirmed. The Blazing Star at one time was one of the important mines of this county, and has been a large producer of gold. The mine has a complete milling equipment, though now somewhat antiquated.

Negotiations for the sale of the Foltz property are reported to have fallen through. An engineer came here to make an examination on an understanding with the owner, but on his arrival at the mine the owner, like Hopkins, in Mark Twain's 'Gilded Age,' raised the price on the prospective purchaser, and the engineer left in disgust, at least such is the report. The vein in the Foltz mine is 16 or more inches wide and carries payable ore. There is a 3-stamp mill on the property.

West Point, May 18.

Plumas County

The International Smelting Co., controlled by the Guggenheim interests, is planning some big developments in the northern part of this county, according to word which comes from Taylorsville, says the Plumas *Independent*.

The company has most of the promising copper prospects bonded in the vicinity of Taylorsville and Gennessee valley, and a great deal of development work is being done on several of the claims. It is stated that at the Five Bears mine, where 15 men have been employed for several months, a fine showing is being made, and that a similar showing is seen at the Iron Dyke copper mine near Taylorsville. Work is also being done on the Copper, Native Son, Austrian Syndicate, and other properties.

It is also reported that the smelting company proposes to develop a large amount of electric power from the waters of Clover creek. It is said that 1000-ft. head can be secured at small expense.

San Bernardino County

(Special Correspondence.)—The Mojave Annex Tungsten Mining Co., owning property in the Clark Mountain mining district, and the New York Mountain mining district, in the east part of this county, each adjacent to the Salt Lake railroad, the former near Roach, Nevada, and the latter near Brant, California, has purchased a 20-ton mill-equipment, a part of which has arrived at the property. The management expects to have the mill erected by the latter part of June, on the New York Mountain property. The development of the mine has opened, in addition to the wolframite-bearing vein, a vein of high-grade zinc sulphide and copper ore, 4 to 24 in. wide, being somewhat irregular. The ore carries an average of 9 to 10% copper and 10 to 40% zinc sulphide. The tungsten content is estimated to carry a minimum of 5% tungsten trioxide. Most of the tungsten ore of this district is wolframite, which occurs in crystals and bunches, large and small. Hübnerite also occurs here.

Brant, May 18.

Sierra County

(Special Correspondence.)—Driving of a lower tunnel at the Monarch Consolidated mine, near Sierra City, will start in a few days. It is planned to intersect the main orebody 200 ft. below the present workings. From the upper levels good ore is being mined and the mill is running 20 stamps constantly. The property was formerly known as the Lee and for several years has been among the premier gold producers of the county.

The Sierra Mining Corporation is arranging for work at the Shamrock property, adjoining the Sierra Buttes mine. It is intended to drive a main adit approximately 4000 ft., and to install equipment at a cost of $10,000. The purchase price was $100,000, of which $5000 has been paid. Much good ore has been opened near surface, and at depth the owners expect to intersect extensions of orebodies that were worked with profit in the Sierra Buttes. San Francisco people are heavily interested.

Everything is in readiness for extensive hydraulic mining at Howland Flat, St. Louis, Port Wine, and other old camps in Sierra county. The massive dam across Slate creek already has been placed in service and work on a limited scale is going on at several properties. An abundant water supply has been provided, and before the close of summer this field is expected to be producing heavily.

The Kanaka Creek mine, worked near Alleghany by Paul D. Propper of Oakland, and Ambrose Madden, is stated to be developing well. Rich ore was recently found in the shaft, and sinking is progressing.——At the North Fork, between Alleghany and Forest, rich ore is reported to have been found last week.

Downieville, May 22.

COLORADO

Boulder County

(Special Correspondence.)—The Mojave-Boulder Tungsten Co. has taken over the Diggs-Clark concentrating-plant in Boulder canyon. The concern has headquarters in New York, It purchased the Bracken group of mines, about 12 months ago, which is one of the best in the district, and has been making a large production. The property is managed by Newton H. Brown.——Buster & Stevens are mining a fine body of tungsten ore in the Barker tract.——Woodring & Dupont, who recently secured the Huron mine at Eldora, have commenced operations.

An advance of approximately 20% in the wages of coal miners of this State will have become effective May 1. About 15,000 miners will receive this increase.

Eldora, May 12.

Lake County

(Special Correspondence.)—Within the past week, the discovery of two high-grade veins, one in the Ibex and the other in the Fanny Rawlings, has greatly stimulated activity on Breece hill and has broken the usually uneventful routine of the district with a touch of the excitement that attended similar strikes in the early days. Both of the recent discoveries are in new territory and promise to be important with reference to the future development of the properties, and in the production of free gold. The strike on the Ibex was made by the Burton Leasing Co., operating on the 1000-ft. level of No. 4 shaft in a part of the property that has recently been developed. The high-grade streak was found in a large vein that has been the source of a steady tonnage of gold-bearing ore for several months. Small pockets of free-gold ore had been mined from the vein previous to the strike of last week, when a continuous streak of the metal was exposed. A bunch weighing 18 lb. was extracted during the week, it being the largest pocket that has yet been found. A shipment of 20 sacks of ore has been delivered to the smelter and a second lot is now being taken out.

At the Fanny Rawlings, the discovery of free gold has been made in one of the big fissure veins that extended into the property from the Ibex, where they were productive of millions of dollars worth of gold ore. The high-grade streak in the Fanny was cut a week ago when a pocket containing 10 lb. of visible gold was opened. The vein is believed to continue through the entire claim and its discovery is regarded as the most important development that has taken place in the property during the last five years. The Fanny Rawlings is being operated by a company of lessees composed of West Virginia capitalists and is being managed by R. W. Coates.

The rapidly growing Government demand for manganese and molybdenum is the cause of unprecedented prospecting for ores bearing these metals; and a number of large deposits of molybdenite and manganese-iron have been uncovered and samples of the ores sent to R. D. George, State Geologist, who is in charge of the Government investigation. Immense bodies of molybdenite ore have been found near the head of the Arkansas valley, at Wortman and Climax, and in the old Independence district west of Twin Lakes. The ores, although low-grade, are believed to be of sufficient value to justify mining. Government geologists probably will inspect the deposits during the coming month and development is expected to follow.

New bodies of manganese have been recently uncovered in the Carbonate, Penrose, Grey Eagle, Home Extension, and Nisi Prius, and 100 tons daily is being shipped from the Penrose and Home Extension, 40 tons from the Nisi Prius, and preparations are in progress to begin extracting ore from the Carbonate and Grey Eagle. Another body of manganese will soon be opened for shipping through the Bohn shaft, which is now being re-timbered. An output of 200 tons a day is being maintained from the Star properties, on Carbonate hill, the ore

being a fair grade of manganese-iron. This tonnage is being delivered to the Colorado Fuel & Iron Co.'s works at Pueblo. In addition to these extensive deposits of manganese, other bodies are reported to have been discovered in the district.

Leadville, May 20.

IDAHO

Kootenai County

(Special Correspondence.)—The Commonwealth mines, on Hayden creek, near Hayden lake, were taken over by the Commonwealth Mining Co. in November 1916, after having been in operation for 25 years under various owners. The vein is large—over 80 ft. wide—of which 24 ft. has been stoped on the 200-ft. level, and proved by milling to be of payable grade. The property comprises a group of seven locations. Since the acquisition of the property by the new company from 12 to 18 men have been steadily employed, except during a period when the miners struck for higher pay, when a small crew continued to work, keeping up repairs. The wage question has been satisfactorily adjusted and everything is now in good condition for the season's work. The old workings have been cleaned out, the lower levels unwatered, and re-timbering done where necessary. Sinking was commenced in the shaft, but had not proceeded far when it became evident that increased pumping facilities were necessary, the shaft making 25 gal. per minute. Better ventilation also had to be provided. A pump-station was cut 20 ft. from the shaft; also a tank below the floor of the level, and the reservoir covered with a plank floor. A Fairbanks-Morse duplex pump, with a capacity of 65 gal. per minute, under 200-ft. head, was installed, and connected with the compressed air line. The sinking-pump was repaired and will be used in sinking the shaft to the 400-ft. level, the water being lifted by the sinker to the tank at the station. Drifts north and south on this level are in $25 ore over a width of 8 ft. It is adjacent to this that the vein carries pay-ore for a width of 24 ft. or more. Raises will be cut to connect levels and good ventilation thus secured. Mining of ore has ceased temporarily, awaiting the completion of ore-bins. In addition to $40,000 spent in development and equipment, buildings have been erected, machinery overhauled, and a large quantity of supplies put in the warehouse. A wagon-road is being built from the mine two miles to Hayden lake, the old road having been destroyed by floods. It is the intention to sink the shaft to 400 ft., to install a hydraulic air-compressor, and a larger hoisting-engine. A mill will be built when ore has been developed on the 400-ft. level. It is estimated that there are 80,000 tons of ore in sight in the huge outcrop, and an additional $100,000 worth above the adit-level, and $60,000 between the adit and the 200-ft. level. Besides this it is believed that a still larger tonnage of valuable ore will be developed between the 200 and 400-ft. levels. Ernest C. Wood is superintendent.

Spokane, May 18.

MICHIGAN

Houghton County

The Calumet & Hecla Mining Co. reports production for the month of April as follows:

Mines	Copper, lb.	For the year, lb.
Ahmeek	2,473,495	9,873,069
Allouez	771,253	3,165,640
Calumet & Hecla	6,855,514	26,969,059
Centennial	125,403	614,670
Isle Royale	1,282,242	4,806,609
La Salle	247,311	711,893
Osceola	1,516,569	6,078,787
Superior	143,614	858,260
Tamarack	478,519	2,143,565
White Pine	453,261	1,340,681
Total	14,347,181	56,562,233

MONTANA

Silver Bow County

The Supreme Court of the United States has decided in favor of the Amalgamated Copper Co. against the Heinze interests in a $15,000,000 damage suit. The Heinze complaint charged the Amalgamated, with the Rockefeller and Lewisohn interests, with attempting a monopoly of the copper industry in Montana, contrary to the provisions of the Sherman anti-trust law. The suit was begun in New York and decided there against Heinze. The Supreme Court affirms the decision. The decision holds that the Heinzes are merely stockholders of the United Copper Securities Co. and that as such they cannot sue for alleged injuries to the company.

NEVADA

Esmeralda County

It is reported that several important discoveries of ore have been made recently in the Goldfield district, and that the outlook for a renewal and continued prosperity is better than for some time past. The introduction of flotation in the mills at Goldfield has opened up a new possibility for the low-grade ores and has stimulated development in no small degree. The Atlanta mine is shipping 50 tons of gold-copper ore daily to the smelters in Salt Lake valley. Some high-grade ore has been found in the Jumbo Extension.

Lincoln County

(Special Correspondence.)—The El Dorado canyon district, near Searchlight, continues to claim interest. Four mills are in operation, the little 2-stamp plant of the Lombard-Carnation company having been started a few days ago. Five more stamps will be added shortly. At an approximate depth of 60 ft. a fair tonnage of $50 ore has been opened.——A hoist has been placed at the Royal Western, and shaft-sinking is proceeding. At a depth of 85 ft. a shoot of sulphide ore, ranging from 10 to 30 in. wide, is exposed, carrying gold and silver.——Six to 18 in. of $80 ore was recently uncovered near the surface on the Clements claim by Clark Alvord. The claim adjoins the Techatticup mine.——Several properties are being examined in the interest of Salt Lake capitalists.

The mill at the Boss mine, near Goodsprings, has been operating several days on low-grade gold-copper-platinum-silver ore, and it is stated that it is making an excellent extraction. Until the plant has been worked up to a high state of efficiency no attempt will be made to mill the higher-grade ore. Occasional shipments of selected ore are being made to Los Angeles by express. Recent mine work has uncovered large bodies of rich copper-bearing ore. O. J. Fisk is manager.

Searchlight, May 18.

Mineral County

The Kentcky Consolidated Mining Co. of Chicago, is erecting a Denver quartz mill and crusher on its property near Sweetwater. The ore will be treated by amalgamation and concentration.

Nye County

(Special Correspondence.)—Placer mining has been resumed at full capacity by the Round Mountain Co., with water from the reservoir in Jett and Jefferson canyons. It is planned to start work this summer on new dams across Jett and Jefferson creeks and impound sufficient water to insure the continuation of hydraulicking well into October of each year. Arrangements have also been made to handle the boulders and cemented gravel blasted ahead of the giants, which is expected materially to lower operating cost. The company is making a thorough milling-test of its low-grade quartz deposits, in the hope of demonstrating the large reserves of this class of ore to be of profitable character. Richard H. Ernest is superintendent.

Round Mountain, May 21.

(Special Correspondence.)—The Orizaba mine, five miles south-west of Cloverdale, has been taken under lease and option by the General Mines Co., of Reno. W. G. Lovie will have charge of operations. Pumps will be installed, the mine dewatered, and the shaft sunk another 100 ft. Two veins have been opened, carrying silver and gold; the ore is stated to average $40 per ton. A heavy flow of water has caused considerable trouble in the past.

The General Thomas lead-silver mine, at Lone Mountain, is stated to be developing well. The Nicholas Lettunich lease recently shipped 70 tons of $60 to $70 ore to the Murray smelter, Utah. Preparations are being made for work by the owners.

Frederick Bradshaw, general manager for the Tonopah Belmont Co. has returned from an inspection of the Surf Inlet gold mine, in British Columbia, and reports the new mill will be completed in the late summer. With the passing of cold weather mine developments are proceeding more vigorously, and construction of surface buildings is making satisfactory progress. The Belmont company has appropriated $50,000 from its treasury for purchase of U. S. Government war bonds, an example other Tonopah companies are expected speedily to emulate.

The Tonopah Extension Co. is installing a 400-kilowatt generator and steam-turbine near its Victor shaft to insure a steady delivery of power to the hoist and pumps, making it independent of delays resulting from unsatisfactory electric-power service. Unwatering of the deep levels of the Victor will be rushed and development of the orebody 60 ft. on the 1500-ft. level commenced.

Tonopah, May 23.

Storey County

The electric motor to operate the pump in the Combination shaft on the Comstock Lode has arrived and will be placed on the foundations promptly. Pumping will soon begin, and the water will be removed from the shaft below the Sutro-tunnel level for the first time in 30 years.——In the Con. Virginia on the 2700-ft. level, the drift is still in good ore and stoping is continued. The ore is to be worked in the Mexican mill.——The Andes is producing considerable ore from the 350-ft. level.—The Ophir is driving north on a promising vein on the 2700-ft. level.

White Pine County

The bullion-tax paid by the Nevada Con. Mining Co. for the first quarter of 1917 was $43,146.33.

(Special Correspondence.)—The Nevada Consolidated company is working at full capacity—about 13,000 tons daily. A day's production was lost last week owing to a wreck on the railroad, when a brake-beam dropped down and ditched 11 cars of ore from the middle of the train, making a bad wreck, the worst in the history of the road.

The new crushing department is expected to be in operation about June 1; this will increase the production 25% or better.

The last annual report of the company shows an increase in the ore reserves of 17,000,000 tons, over and above the production last year; there now being 68,000,000 tons of 1.59% ore in sight. This proves what has often been stated that the Nevada Consolidated property was not a short-lived one, but will still be producing 25 years hence.

The Consolidated Copper Mines (old Giroux) is running about 600 tons daily through the mill, and shipping some high-grade native-copper ore from the old Alpha workings. Mr. Hogan, formerly of Butte, Montana, is in charge at the New Giroux shaft on the west side.

The Ward property, 17 miles south of Ely, is shipping daily by means of two tractors and trailers, 12 tons of ore to the trip.

The Ely Consolidated, of which Sam Levy is president, is shipping a car of lead-silver ore this week from the American shaft.

H. S. Williams is leasing on the Jack Rabbit claim and taking out lead-silver ore. Gilmer Bros., of Salt Lake City, are shipping some copper ore from the Lucky Deposit at the old camp of Aurum, in the north-eastern part of the county.

Shipments of ore are now being made from Hamilton by way of Eureka. The manager of the Pallisade & Eureka Railroad shut-down May 1 rather than haul the mails for Uncle Sam at the contract price, but he found that the State Railroad Commission had something to say concerning this, and was glad to start up again and promises to be good.

The camp of Ely generally is prosperous, much building going on, houses all full, it being hard many nights for strangers to secure a bed; there is always a surplus of men here. It is hard to say why, as a shortage is general in other camps in the State.

Ely, May 18.

(Special Correspondence.)—Ott. F. Heizer, general manager for the Louisiana company, operating the old Tybo mine, reports that they have commenced pumping water from the mine, and this week are shipping ore from the upper levels, and from the dumps. This ore is of a very good grade. They are using the Duplex tractor, four-wheel drive, making a round trip to Tonopah in two days, a distance of 68½ miles, at a cost, including depreciation, of less than $8 per ton; they haul seven tons to the trip using one trailer. It is believed that this old mine will again make good.

It is a vein in limestone, and is continuous for three miles, generally mineralized wherever opened up. It is said to be an exception to the rule, as the value of the ore increases with depth, being 60% better on the fourth level than on the third.

Ely, May 21.

NEW MEXICO

Socorro County

(Special Correspondence.)—About 20,000 oz. of gold-silver bullion was cleaned-up at the Socorro mill for the first half of May. The mill is being run to capacity, treating ore from several of the company's own properties, as well as ores from the Oaks Company.

Driving in the Johnson mine is being done by machine-drills. The ore taken out in development is shipped to the mill.

The Oaks Company has increased its ore shipments on the Maud S. Ore of mill-grade has been opened up in another new place during the week and this property is beginning to take on its old-time activity. The mine has produced nearly $1,000,000.

Pay-day throughout the district will take place twice a month in the future; this being in accordance with the new State law.

Mogollon, May 22.

OKLAHOMA

Comanche County

The High Five Mining Co. operating in the Lawton-Waco field has been rewarded by its persistent drilling in search for ore. The company began drilling several months ago, and met with small encouragement. Hole after hole was put down with only a small showing of ore in some places, and none at all in others. In the 29th hole, however, the strike was made. At 103 ft. from the surface ore was found and the drill continued in ore to a depth of 257 ft., with ore still in the bottom. Hole No. 30 was drilled and again at 103 ft. from the surface ore was reached and the drill was still in good ore at 202 ft. In this hole the grade of ore is better than that in No. 29, running, it is said, 10% blende. The area will be delimited by drilling. Had the company been discouraged by the repeated failure to find profitable ore in the first 28 holes, the rich strike would not have been made. Now the company proposes to build a mill as soon as materials can be placed on the ground.

OREGON

JOSEPHINE COUNTY

(Special Correspondence.)—A mining deal of considerable importance to the copper industry in southern Oregon was closed at Grants Pass this week, when an option on the 20 claims comprising the Greyback copper group on Greyback mountain, 13 miles east of Selma, in the Waldo district, was signed. The lessee is John Hampshire, the local representative of Twohy Bros. Company, owners of the California-Oregon Coast railroad, which is being operated and built from Grants Pass into the Waldo district. The company has been a large buyer of mines in that district during the past three years, and are the owners of the Queen of Bronze copper mine, and the 100-ton smelter, both located at Takilma, in the Waldo district. Under the terms of the contract development work must be started on a large scale at once. The new owners announce that their first work will be the building of a six-mile road connecting the mine with the road leading up Deer creek from Selma, and the shipment of some of the ore now on the dumps. More than 700 ft. of development has been done on the main vein, opening one of the largest copper-bearing orebodies in the district. It lies on the north-south copper lode that extends through the Waldo district, and on down into northern California.

The property has been sold by W. L. Babcock, who has owned and developed the property for 16 years. It is the only property in the State where mining locations on the Oregon & California lands have been litigated through the Supreme Court and the title secured by having the patents to the railroad canceled.

Grants Pass, May 20.

TRANSVAAL

A cablegram has been received from the head office of the Transvaal Gold Mining Estates (Ltd.) advising the results for March as follows: Tons milled, 16,635; estimated value of month's output, £31,515; estimated profit, £7986.

Glynn's Lydenburg (Ltd.) reports the results for March as follows: Tons milled, 4115; estimated value of month's output, £8602; estimated profit, £3757.

The Rand Mines (Ltd.) reports results for March as follows:

	Tons milled	Estimated value	Estimated Profit
Modderfontein B. Gold Mines, Ltd.	46,500	£96,655	£49,250
New Modderfontein G. M. Co., Ltd.	56,000	124,500	65,703
Rose Deep, Ltd.	61,500	74,744	19,094
Geldenhuis Deep, Ltd.	56,240	70,384	11,079
Nourse Mines, Ltd.	45,000	59,910	10,350
City Deep, Ltd.	66,000	128,719	60,110
Village Deep, Ltd.	49,200	75,816	16,187
Ferreira Deep, Ltd.	49,630	82,529	27,086
Robinson Gold Mining Co., Ltd.	55,300	59,479	18,476
Crown Mines, Ltd.	190,000	233,626	54,725
Durban Roodepoort Deep, Ltd.	29,650	40,217	5,192
			Est. loss
Bantjes Consolidated Mines, Ltd.	23,300	21,289	4,517

The output of diamonds in the Transvaal during 1916 was 615,209 carats, valued at £933,643. Copper ore to the value of £623,872 and tin ore valued at £353,027 was also produced during the year. The gold output of Witwatersrand was £38,107,909, and of other outside districts of the Transvaal was £1,377,025, making a total of £39,484,934.

KOREA

The Seoul Mining Co., operating the Suan Concession in Whanghai province, Chosen, reports for the month of April, total recovery, $147,345.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

CHARLES BUTTERS is leaving for Chile.

SEELEY W. MUDD was in San Francisco.

JAMES M. HYDE is at Silverton, Colorado.

WALTER H. ALDRICH will be in San Francisco about June 1.

JOHN C. RHOADS has returned to San Francisco from Mendocino county, California.

F. O. BROILI has been appointed field engineer for the State Engineers office of Nevada.

DUNCAN MACVICHIE is investigating mines of the Deep Creek district in western Utah.

A. J. SALE of Los Angeles was in San Francisco, and has gone to Battle Mountain, Nevada.

F. L. SIZER has returned to San Francisco from a visit to the deep gold mines in Amador county.

WILLIAM A. ARGALL has joined the Colorado Field Artillery and is now at Fort Logan, near Denver, Colorado.

HARRY MORRIS, representing the Angels Iron Works, has opened an office at 1206 Hobart building, San Francisco.

CHARLES B. CRONER, of Pasadena, recently examined the Admiral Schley property, near Greenwood, in Eldorado county, for the Los Angeles owners.

E. W. BULLARD, editor of the *Bulletin Board* of San Francisco, has received a commission as Second Lieutenant, and is in the Officers' Reserve training camp at the Presidio.

V. C. SUCKOW, chief inspecting engineer with Falkenburg & Laucks, Seattle, Washington, has received a captain's commission in the Engineers' Corps and has reported for duty at the Presidio at San Francisco.

GEORGE W. BLACKINTON, Denver representative of the Sullivan Machinery Co., has gone to Ft. Riley to take the Officers' Reserve Corps training. M. R. BLISH, of the Chicago office, succeeds Mr. Blackinton in Denver. SIDNEY F. GREELEY, of the Chicago office of the Sullivan company, and also FREDERICK W. COPELAND, son of the president of the Sullivan company, have gone to Ft. Sheridan to take the Officers' Reserve Corps training. Mr. KENNISTON, of the San Francisco office of the Sullivan company, has enlisted in the aviation corps of the army and has gone to San Diego for training.

Obituary

C. C. LEAVITT, who was well known on the Pacific Coast as a mine operator and manager, died at Jerome, Arizona, on May 10. He was for some time superintendent of the Copper King and Fresno copper mines.

ARNOLD HAGUE died on May 14 at Washington. He was one of the most notable geologists of America, belonging to that group of broadly educated and far-seeing men around whom the development of the West has seemed to grow as a vital and undying tribute. He was born in Boston in 1840, and graduated from the Sheffield Scientific School at Yale in 1863. Thence he went abroad, securing the advantages in succession of the Universities of Göttingen, and Heidelberg, and the Freiburg School of Mines. He became assistant geologist under Clarence King, and soon had acquired fame for his abilities, so that his services were in wide demand. His activities covered many countries, and several universities have honored themselves by honoring him with degrees that recognized his fine discriminating scholarship. He was identified with scientific progress in many phases, and has left an indelible impress upon his times.

THE METAL MARKET

METAL PRICES

San Francisco, May 29

Antimony, cents per pound	23.50—25.00
Electrolytic copper, cents per pound	33
Pig lead, cents per pound	10.25—11.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$95
Spelter, cents per pound	11.50
Tin, cents per pound	65
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, May 29

Antimony, 50% metal, per unit	$1.70
Chrome, 40% and over, f.o.b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tungsten, 60% WO_3, per unit	20.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 45% (under 35% metal not desired), cents, unit	36—38

Manganese prices and specifications, as per the quotations of the Carnegie Steel Co. schedule of prices per ton of 2240 lb. for domestic manganese ore delivered, freight prepaid, at Pittsburg, Pa., or Chicago, Ill. For ore containing

	Per unit
Above 49% metallic manganese	$1.00
46 to 49% metallic manganese	0.98
43 to 46% metallic manganese	0.95
40 to 43% metallic manganese	0.90

Prices are based on ore containing not more than 8% silica nor more than 0.2% phosphorus, and are subject to deductions as follows: (1) for each 1% in excess of 8% silica, a deduction of 15c. per ton, fractions in proportion; (2) for each 0.02% in excess of 0.2% phosphorus, a deduction of 2c. per unit of manganese per ton, fractions in proportion; (3) ore containing less than 40% manganese, or more than 12% silica, or 0.225% phosphorus, subject to acceptance or refusal at buyer's option; settlements based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken to be deducted from the weight Prices are subject to change without notice unless specially agreed upon.

EASTERN METAL MARKET

(By wire from New York)

May 29.—Copper is firm, with prices nominal at 32.50c. Lead is strong and higher at 11 to 11.25c. Zinc is dull and firm at 9.50c. Platinum is unchanged at $105 for the soft and $110 for hard.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
May	23 — 74.62	Apr.	17 — 73.27
"	24 — 74.62	"	24 — 74.08
"	25 — 74.62	May	1 — 74.06
"	26 — 74.62	"	8 — 74.92
"	27 Sunday	"	15 — 74.69
"	28 — 74.62	"	22 — 74.78
"	29 — 74.62	"	29 — 74.62

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	72.51	Oct.	49.40	67.86	....
May	49.87	74.27	....	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

The silver market remains narrow and sensitive, and, as has been the case recently, very little buying or selling has an effect on the market totally disproportionate to the amount changing hands. For instance, on April 27, quite a moderate amount of buying caused a rise of 5s.16d., and a few further orders on May 31 were responsible for a similar movement of 3s.8d., and today of 1s.4d.

For the fourth consecutive week there has been a reduction in the amount of silver coin and bullion held in the currency reserve in India. It now amounts to only 1537 lacs, the lowest since November 25, 1913.

The stock in Bombay consists of 1500 bars and is unchanged.

The stock in Shanghai on April 28 consisted of about 26,800,000 oz. in sycee and $17,400,000, as compared with about 26,500,000 oz. in sycee and $17,200,000 on April 21, 1917.

The last three Indian currency returns received by cable give details in lacs of rupees as follows:

	April 15	April 22	April 30
Notes in circulation	8447	8340	8272
Reserve in silver coin and bullion	1674	1629	1537
Gold coin and bullion in India	1219	1156	1130
Gold in England	592	892	517

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
May	23 — 32.50	Apr.	17 — 32.75
"	24 — 32.50	"	24 — 31.47
"	25 — 32.50	May	1 — 30.43
"	26 — 32.50	"	8 — 31.37
"	27 Sunday	"	15 — 32.00
"	28 — 32.50	"	22 — 32.25
"	29 — 32.50	"	29 — 32.50

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	33.16	Oct.	17.90	28.50	....
May	18.71	29.02	....	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
May	23 — 10.75	Apr.	17 — 9.35
"	24 — 10.87	"	24 — 9.43
"	25 — 10.87	May	1 — 9.62
"	26 — 10.87	"	8 — 9.93
"	27 Sunday	"	15 — 10.49
"	28 — 11.00	"	22 — 10.50
"	29 — 11.25	"	29 — 10.93

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	9.38	Oct.	4.62	7.02	....
May	4.24	7.38	....	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

The Hecla Mining Co. of Wallace, Idaho, declared dividend No. 168 of 15c. per share, $150,000. Total for 1917, $750,000. Total paid to date, $6,055,000.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound

Date		Average week ending	
May	23 — 9.50	Apr.	17 — 9.87
"	24 — 9.50	"	24 — 9.58
"	25 — 9.50	May	1 — 9.23
"	26 — 9.50	"	8 — 9.61
"	27 Sunday	"	15 — 9.37
"	28 — 9.50	"	22 — 9.37
"	29 — 9.50	"	29 — 9.50

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	10.20	Oct.	14.05	9.05	....
May	17.03	16.01	....	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Date		Week ending	
May	1 — 113.00	May	15 — 106.00
"	8 — 113.00	"	22 — 95.00
		"	29 — 95.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	114.50	Oct.	92.90	78.20	....
May	75.00	90.00	....	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

Quicksilver: On account of very little demand during the past week, the sellers have reduced their quotation to $105 at New York, though quantities can be had at even a lower figure than this. Foreign quicksilver is offered from $95 to $100 according to position The San Francisco quotation is $95.

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	48.25	51.49	55.63	Oct.	33.00	41.10	....
May	39.28	49.10	....	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Platinum is quoted at $105 for soft unalloyed metal and $110 for the hard natural platinum-iridium alloy.

According to the British consul at Ekaterinburg, Russia, the 1916 output of platinum in the Urals amounted to 86,500 troy ounces, only about three-fourths of the output in 1915. The chief causes of the decline in the production of platinum are the shortage of labor, the difficulty in obtaining spare parts for dredges, and the exhaustion of the richer alluvial deposits. New alluvia will undoubtedly be found when extensive prospecting is resumed.

Manganese: Manganese is very much in demand and even ore which formerly was not finding a market in New York is now easily absorbed by consumers. Any ore from 36% up, and if of desirable composition, can now be sold. High-grade ore is quoted at $1 per unit.

Antimony: The antimony market fluctuated very little during the past week. Considerable business has been done at prices ranging from 24½ to 25½c. for early and spot delivery with forward delivery quoted from 16 to 17c. per lb. according to position. Needle antimony is quite firm for spot delivery and 12½c. has been paid. Future ore is quoted at 9 to 9½c. according to month of shipment. Antimony ore has again changed hands at $2 30 per unit and short ton, and more business is possible at this figure if freight can be obtained from South America.

ORES

Tungsten: Canada is a recent inquirer for both concentrate and the ferro-alloy, the quotations for which are about $18 to $20 per unit for 60% ore, and $2 to $2.15 per lb. of contained tungsten in the ferro-tungsten. The market is rather quiet as compared with the active one of the past few weeks. The official quotation of $20 per unit for 60% concentrate is the only one offered by some sellers.

Molybdenum: There seems to be a good demand for the ore but not much offered. The market is quiet at unchanged prices from those formerly quoted.

Eastern Metal Market

New York, May 23.

Strength characterizes the entire metal market, but in general the amount of business really done is not large.

Copper is entirely nominal, especially for the early positions, and transactions are small.

Zinc is firmer with a strong undertone, but the market is very dull.

Lead continues scarce, and any buying forces the market up.

Tin is quieter than last week, but is high and strong.

Antimony is in fair demand and is steady at about the same prices as last week.

Nothing seems to impair the strength of the steel market. Deliveries and mill conditions grow worse instead of better, and capacity is so completely sold up that interest normally in new business is greatly lessened. Foreign inquiries are still very large, but they result in few orders, due to uncertainty as to Government orders and needs. Advances in semi-finished steel show no let-up, sheet-bars having recently sold at $95 per ton. Large foreign tin-plate sales could be made, but doubt is expressed whether shipments out of the country will long be allowed. A copper price of 24 to 25c. per lb. is not improbable for Government and general war needs.

COPPER

The market could hardly be more nominal than it now is. Metal for delivery this side of August 1 is very hard to obtain, second-hand or re-sale dealers being the only medium. Some business is reported for these deliveries, but it is not large. The quotation for spot delivery is reported by some at 33c., New York, with May and June at 32 to 32.50c., though others quote as low as 31.50c. In the absence of sales of any amount, definite quotations are extremely difficult and entirely nominal. Third-quarter metal is generally quoted at 28.50 to 29.50c., New York, with some business being done. The market is largely a waiting one, pending a definite programme as to the Government's and Allies' needs and purchases. A desire is manifested by consumers to be kept posted as to conditions, but they exhibit little inclination to buy. Attempts on the part of one or two sellers to create an interest in nearby shipments were without satisfactory results. Despite the submarine blockade of our ports since February, exports of copper in the first four months of this year have exceeded any previous four months before or since the War began. With those for April estimated, exports to May 1 of this year have been in excess of 170,000 gross tons, which compares with the best previous four-month record of 152,000 tons early in 1914, when Germany was preparing for the War that began late that year. "Allowing for a submarine loss of 5000 tons per month, the allied governments have received as much American copper since January 1, 1917, as all the foreign countries together took in the corresponding period of 1914." This from the copper sub-committee of the Raw Materials committee of the Council of National Defense, with John D. Ryan, president of the Anaconda Copper Company as its head, is regarded as a bull-argument as to the future and the war purchases.

TIN

The market at present is dull and quiet, but very strong. Fairly good sales were made on May 16, probably 250 tons in all, mostly for spot and nearby shipment, at 66.25c., New York, with about 50 tons sold on the following day, all spot, at 65.25c., New York. Since then the market has been dull with the quotation on May 18 at 65c., New York, for early-delivery metal, with small sales reported. Yesterday and on Monday the market was dull with small sales of nearby metal, and more offered than sold, the settling-price being 65.25c., New York. The quotation yesterday was 65.50c., New York, for early delivery. Spot supplies are strongly held and the market is a narrow one. Reasons advanced for the present dullness are that sellers are uncertain as to their future supplies, especially as regards permits from England and the safe arrival after they are afloat. This has caused a decided hesitation. Buyers, on the other hand, are proceeding slowly, and have good reasons for so doing. Most of them are probably well covered, but they do not know where they stand as to the proposed Government tax, one statement being to the effect that the tax will go into effect on the date of the bill. These considerations cause an unsettling condition, and also contribute to hesitation among buyers in general. The London market is still very strong. Yesterday the quotation there for spot Straits was £254 7s.6d. per ton, an increase of £1 7s.6d. over last week, bringing the total advance in two weeks to over £22 per ton. This strength has its influence on the market also. The quantity afloat, to May 21 inclusive, was 3422 tons, with the arrivals for the same period at 3525 tons.

LEAD

Most of last week prices remained stationary but firm, but there has been an advance this week. Yesterday the quotation was 10.87½c., New York, or 10.72½c., St. Louis, as compared with 10.50c. for most of last week. Some metal was sold on Monday, May 21, at 10.75c., New York, and one dealer reports a sale of a carload yesterday at 11.75c., New York. Some producers are attempting to keep the market from advancing, but without success. This week there has been a good demand for prompt and June metal. No liberal sales are reported as having been negotiated quietly. The market's strength rests in the probable Government purchases of large quantities, with the supply possibly insufficient to prevent a decided scarcity. The American Smelting & Refining Co. advanced its price on May 17 from 9.50 to 10c., per lb., New York. The London quotation yesterday for spot lead was £30 10s. and for futures £29 10s. with the market firm.

ZINC

It is very unusual to record that the quotations for spot and May are practically the same as those for June, July, and even third quarter; that futures are as high or higher than early-delivery metal. Such is the interesting and anomalous case today. Sellers and producers are unwilling generally to bind themselves for deliveries much beyond June, and some have refused firm offers at present quotations for third quarter. One or two, however, quote about ¼c. less for third quarter, but report no business. The price has stiffened somewhat in the last day or so after having remained almost stationary for some days. Spot and May or June prime Western is quoted now at 9.25c., St. Louis, or 9.50c., New York, which may also be said to be the price for July or third quarter. There is practically no demand, but the fact that ores are stiff, and that Government buying is bound to be large sooner or later exercises a steadying and firm influence. The needs of the Allies are also figured as likely to be large.

ANTIMONY

There is little change in this metal from the situation last week. The price is about the same for the early delivery of Chinese and Japanese grades, 25 to 26c., New York.

ALUMINUM

Prices are maintained by the present moderate demand because supplies are not large. A report is current to the effect that the United States government has been granted the regular contract price of 37c. per lb. for aluminum by the Aluminum Company of America. Quotations for No. 1 virgin metal, 98 to 99% pure, are unchanged at 59 to 61 cents.

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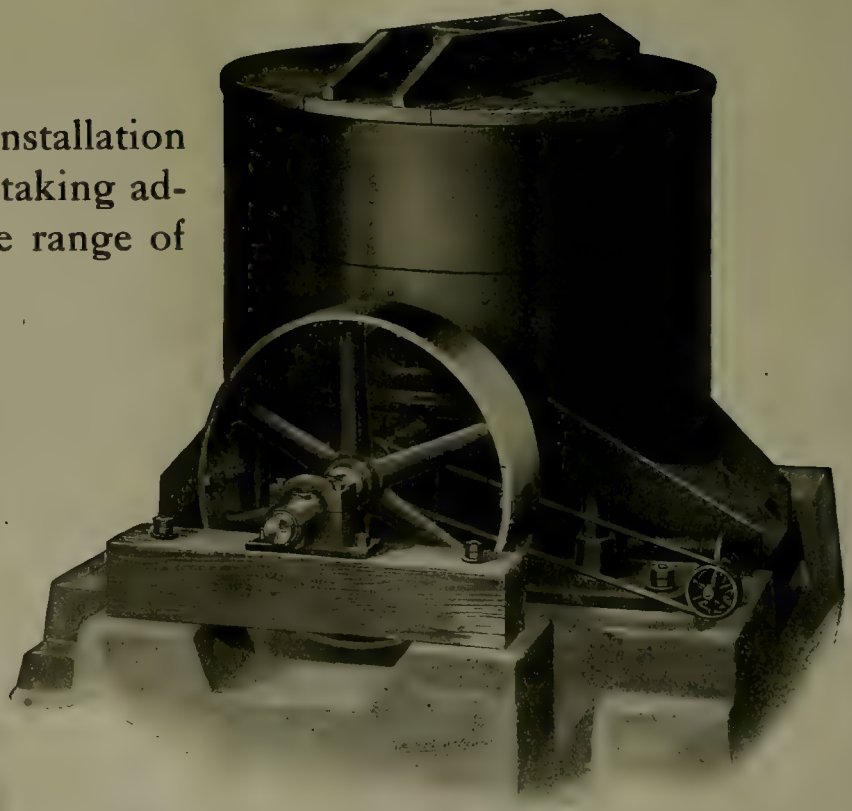

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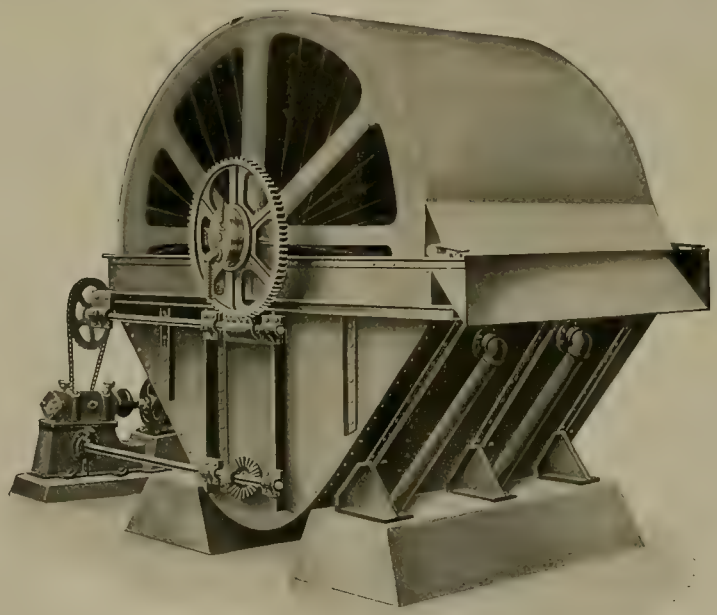

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Notes on Compression and Transmission of Air
Theory of Ore Flotation

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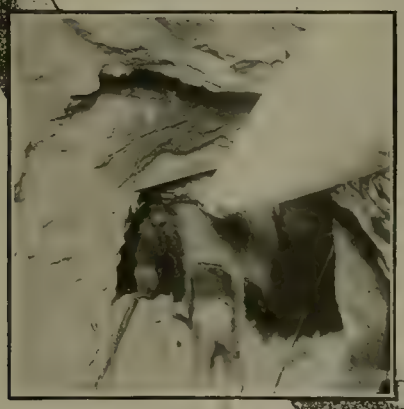

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T. A. RICKARD - - Editor
COURTENAY DE KALB, Associate Editor
W. H. STORMS - News Editor

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Description and plans of a modern powder-thawer, with working drawings and costs. M. & S. P., June 9, 1917.

DEPARTMENTS

REVIEW OF MINING 812

Special Correspondence from Juneau, Alaska; Mayer, Arizona; Manhattan, Nevada; Sutter Creek, California.

THE MINING SUMMARY 816

PERSONAL 820

THE METAL MARKET 821

EASTERN METAL MARKET 822

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EDITORIAL

T. A. RICKARD, Editor

EIGHTEEN leading copper companies have announced their subscriptions to the Liberty Loan. The total thus subscribed is $8,500,000. The Anaconda heads the list with a subscription of $2,500,000, followed by Inspiration and Miami with $1,000,000 each.

CAPITALIZATION of the new oil companies organized in Wyoming in the first three months of this year, aggregates the modest sum of $189,175,000! This total has been further increased by large additions since April first. A single company was incorporated with a capital stock of $10,000,000. So numerous and evidently over-capitalized are most of these concerns that they have attracted the attention of the Federal Government, which is not too busy with preparations for war to ascertain whether the ready money of the public is likely to be as usefully employed in purchasing stock in mushroom oil-companies as if it were invested in Liberty Bonds.

COPPER production today, despite the higher wages paid, and the enormously increased cost of supplies and new equipment, is maintained at a cost per pound equivalent to the average reached seven or eight years ago. For example, the costs per pound during the first quarter of the present year were 10.843 cents at the Utah Copper, 11.02 cents at the Nevada Consolidated, 10.12 cents at Chino, and 11.084 at Ray. These figures represent a marked increase over those prevailing three years ago, yet it is interesting to observe that wholesale mining and milling methods and advances in scientific management have made it possible to produce this metal during a period of war on a par with the best attainable achievements of less than a decade ago when the cost of supplies was 50% below present market quotations.

HIGH-GRADING may have been developed into an art simulating some of the skilful flights of frenzied finance, but the accusation that the United States Mint at San Francisco had purchased $7,000,000 of such contraband bullion in the last five years, and that the authorities, with childlike simplicity, had recently paid out $500,000 to unidentified parties, is altogether too saffron-colored a tale to be passed over as a mere vagary of the yellow press. The watchdogs of our national treasury are not behaving in that somnolent manner. The Colorado high-graders have in fact made shipments from time to time to the San Francisco mint, and the result has been investigation leading to arrests. When a man pays expressage on bullion from Colorado to San Francisco instead of taking advantage of the Denver mint, this striking disregard of the fundamental principles of economy awakens the suspicions even of an easy-going Federal servant.

TIN-PLATE for cans consists by weight of 2 parts tin and 98 parts steel. The Department of Commerce has just issued a bulletin on this subject, intended to stimulate the production and use of substitutes for 'tin' cans, calling attention to the extraordinary demand for tin containers, exceeding by nearly 40% the consumption last year. If the demand were warranted, it is evident that the shortage would not have been made good in time to save the crops. We explained, however, in a recent issue, that a considerable proportion of the demand that sent the price of tin soaring was due to the fear of small packers that allotments would be made *pro rata,* in consequence of which they called for quantities of cans in large excess over their actual requirements. We pointed out that the scarcity of tin was more apparent than real, and that in our opinion the market would soon reflect the true condition. At a matter of fact the demand for tin promptly discouraged the exorbitant quotations, and our New York correspondent now records an exceedingly dull market, with a decline to 62½ cents. We anticipate still lower figures, indicating that the danger of a serious shortage is past.

INTERESTING statistics of our natural resources have been issued in summary by the Mechanics and Metals National Bank of New York, from which it appears that the national wealth per capita is $2404, the national indebtedness $28.80, the money in circulation $45.60, and the gold money in the country $26.44. The value of the agricultural output in 1916 was $73.46 for each person, the copper produced was 23 pounds, while the pig-iron amounted to 760 pounds. The output of raw materials this year will result in perplexing disproportions. Foodstuffs and cotton will be only slightly augmented, but the metals will show an increase that signifies an enormously greater labor-factor that must put an unusual strain upon our capabilities of supplying provisions at prices that will be within the reach of the people. A forecast of the coming stringency may be deduced from the steel trade alone. Orders booked by the United States Steel Corporation at the end of April last year called for 9,829,511 tons of steel; this year the orders on the same date demand an output of 12,183,083 tons. Taking another measure, we find that the railroad earnings on 26 of the largest roads for the second week in May exceeded by $1,110,507 their net income for the same period in 1916. These few figures, illustrating the sudden growth in volume of those industries that must attract increasing

numbers from the farms, are impressive indicators of the seriousness of the food problem, which has not been as universally credited as the case warrants.

FURNACE-CONSTRUCTION in the Eastern States is so excessive that the demand for refractories is out of all proportion to the supply. Not only is the price of such material advancing by leaps and bounds, but it is becoming generally impossible to obtain the necessary bricks. The manufacturers of such supplies are increasing their equipment with the utmost rapidity. The Pittsburgh Refractories Company is sold out already for over two years, and other companies are in nearly the same position. The American Refractories Company is just completing a new plant at Baltimore, this being the seventh established by that concern, and this single addition will have a capacity of 30,000 magnesite and chrome bricks daily. Active prospecting for these two substances has developed a state of excitement throughout a considerable part of California, in which State magnesite is found in at least 15 counties, and chromite in 26. Imports of chromic iron into the United States increased from 76,455 tons in the year 1915 to 114,655 last year. The present demand will absorb all that can be offered.

CARRANZA has again ruffled the waters of peace. Nothing serious has occurred as yet, but such a cryptic utterance as that in his recent post-prandial remarks hinting darkly that Mexico might be drawn against its will into the world conflict accords with the inferences we have been forced to draw from his feeble protestations of neutrality, accompanied by his recommendation to other Latin-American nations to refrain from shipping supplies to the Entente Allies. Mr. C. W. Barron has intimated through the *Boston News Bureau* that the Mexican officials have suddenly grown polite to Americans on observing Uncle Sam take down his rifle from above the fireplace and load it with real powder and ball, but the most optimistic could hardly anticipate that Carranza would now co-operate with the United States, though it is never too late to show a sense of gratitude for favors done. It is time that the Mexican people should realize that this country does not and never did desire or contemplate annexation of their territory. Our acts throughout the revolution have demonstrated unselfish friendship for the Mexican nation, despite occasional clashes due to some unfortunate misunderstandings.

MAINE was an early mother of copper smelters, as Georgia was the home of the gold miners that laid the foundations of Californian milling practice in the days of Forty-nine. Just across the bay from Mt. Desert, at the old fishing port of Blue Hill, is a once-famous copper mine, where works existed that were notable in their day. The ore was roasted in heaps, and smelted in reverberatories in the early Welsh manner. Here were trained men that later became foremen and managers of copper smelters in the West and that helped to establish industries so much bigger as to make Blue Hill seem like the play of children. So suddenly was the operation brought to a standstill by superior orders that half-burned ore-heaps were left in the roast-yard, and a full charge of copper, oxidized to the point where it was ready for poling, was left untapped in the refinery. That frozen bath of oxidized copper has been used many times as a lure by promoters seeking to revive the mine. Now comes the American Smelting & Refining Company, which finds in the silicious chalcopyrite ores of this long abandoned mine a needed flux to assist in its smelting operations at Perth Amboy, New Jersey.

SHORTAGE of bottoms has nowhere been more severely felt than in the nitrate trade. Despite the growing need of sodium nitrate the exportation from Chilean ports for the first quarter of this year was only 800,656 tons, being 30,363 tons less than for the same period in 1916. The Department of Commerce announces that it is impossible to secure sufficient nitrate from Chile for use this season, and the Government is able to release only 4000 tons, which cost $60 per ton at seaboard. The quotations in the open market are $76 per ton. While no large deposits of nitrates exist in America, the time has come for utilizing the small concentrations that occur in various basins in the arid West, notably in Inyo, Riverside, and San Bernardino counties, in California. Furthermore, the mineral nitrocalcite is much more abundant than is generally known. It is frequently to be found, if searched for, in the seams, joint-planes, and other spaces in limestones in the desert countries underneath what are known as bat-caves. Nitro-glauberite is also found frequently as an efflorescence and as fibrous masses, in the desert bolsones. The prospector is the man above all others to possess information of these occurrences, and this would seem to present an opportunity for the individual to make a little grubstake by collecting nitrates, at the same time helping to make up the deficiency in this needed material. In the aggregate some thousands of tons might be collected from small isolated deposits within the next few months.

MINERAL development is essentially a story of disappointments over-topped by luminous splendors of success. With ceaseless iteration come tales of waning hopes, followed by sudden discoveries of ore just beyond the latest workings. Were not the persistence of the miner greater than the average persistence of the ore when he finds it, the metal output of the world would be immeasurably reduced. A new example comes from the Waco-Lawton zinc district in Oklahoma. The High Five Mining Company entered upon a drilling campaign; hole after hole proved blank, but, with fine determination, those in control would not permit twenty-eight failures to dampen their enthusiasm. The twenty-ninth hole passed through 154 feet of pay-ore and the thirtieth hole confirmed the revelations of its predecessor. It furnishes an interesting object-lesson, not in apology for the 'wild-cat' but in approval of the sane adventurer.

Such exploration is for the man that can afford to lose; it is for him that can play fair toward himself and toward every other party interested in the outcome. One drill-hole, or a half-dozen, cannot be expected to settle the matter. The safety of numbers in deducing a correct average is not there. The owner of property that is deemed worth drilling should protect himself by requiring enough drilling to insure demonstration: the engineer should wash his hands of the enterprise that he may have recommended, unless his clients agree to a sufficient amount of work to prove the ground; the company that is unwilling to venture enough to get the truth had better convert itself into a syndicate for buying Government bonds. The Oklahoman, like the Missourian, was in doubt until the 29th hole showed him something, and he is still uncertain until he has drilled 29 more, and then . . . more!

Potash

Some years ago the United States was content to believe, and even freely acknowledged, that Germany held a world-monopoly in potash, and consequently that our grains and grasses and the greater part of our most nutritious foods were dependent upon the rejuvenation of our soils by this precious alkali, which came exclusively from the mines at Stassfurt. We were also taught to believe that the only possible rival of Stassfurt was the great salt deposit of Kalusz in the Carpathians; but what is Austria's is Germany's, as has abundantly appeared in the sequel, confirming the darkest fears of Metternich. Recently the German technical staff has indulged in jubilant comment upon the crop-shortage in the United States for the season of 1916, attributing it directly to a scarcity of potash. As a matter of fact the diminished harvest last year, and the threatened deficiency in 1917, are the result of inclement weather-conditions in Western areas where fertilizers as yet have scarcely been applied to soils. Nevertheless there is an immediate scarcity of potash, and the price is correspondingly high, with a relatively inactive market. The increase in price from about $30 per ton for the chloride in normal times to $400, as now quoted, exerts a restraining influence on the agricultural demand as reflected through the manufacturers of fertilizers. The farmer is content to let the plants starve a little if necessary. It will be seen that, with such high prices for plant-foods, the farmers' investment in a growing crop is enormously increased, and the losses incident to unfavorable weather-conditions become increasingly great, introducing risks that might easily become ruinous. This situation deserves the serious consideration of the Government, and amid the host of other problems neither Congress nor the Departments of Agriculture and Commerce seem to have seriously grappled with the question.

An interesting fact, which should be made clear in order to create a correct public opinion upon this matter, is that we are not necessarily dependent on *Mittel Europa* for potash. Some of the cement-mills of America are making nearly as much money at this moment out of their by-product recovery of potash as they derive from the cement itself. Every cement works today is becoming a potash factory. The iron blast-furnaces are also preparing to enter the field. Not long ago Mr. R. J. Wysor of the Bethlehem Steel Company made an elaborate investigation into the possibilities of recovering larger quantities of potash than heretofore from the blast-furnace gases. He found that 20% of the original potash content remained in the gases after passing through the scrubber, and furthermore that the larger proportion of the total potash is dissolved and lost in the primary and secondary washers. An average furnace-charge at Bethlehem contains about 22 pounds of potash per ton of pig-iron produced, of which only 20% is carried off in the slag, leaving 80% that may in part be recovered from the gases. Mr. Wysor states that the gases when passed through an experimental Cottrell electric dust-precipitator yielded practically all the potash in the collected precipitate. The saving effected by the same means at the cement factories ranges from 90 to 95% of the potash in the kiln-gases. It thus appears that in Pennsylvania alone, which produces normally ten million tons of pig-iron per annum, assuming a net recoverable 10 pounds of potash for each ton of pig-iron, 50,000 tons of potash might be made available yearly. Ohio would yield half as much on the same basis. In Alabama the outlook is still more remarkable. The so-called 'gray ores' are exceptionally rich in potash, containing over 80 pounds of the alkali per ton of iron on the charge. The additions from coke-ash and flux bring up the total to nearly 100 pounds. Mr. Charles Catlett has estimated that a net recovery of 77 pounds of potash per ton of iron can be obtained in connection with the smelting of these ores. By the installation of the necessary equipment it is evident that the iron industry alone can supply over one-third of our normal demand for potash, obtainable at relatively insignificant cost as a by-product. The cement industry can do as much, so that our survival among the nations of the earth manifestly does not depend upon the favor of Germany. As a matter of fact we have not yet begun to realize upon these resources as we must. In 1916 the total output of by-product potash in the United States was only 8264 tons, with an additional 1550 tons derived from the treatment of kelp. The foregoing figures include molasses distillery waste, which contributed 1845 tons. It is not creditable to the energy and foresight of our people that we should have provided only 5% of our normal consumption of this vital necessary, when 60% at least is immediately available by the application of means that have been developed by Mr. Frederick G. Cottrell and his associates, and proved successful in operation.

Aside from this the production of potash from feldspar has been advanced to the commercial stage within the past few years. The Spar Chemical Company has established works at Baltimore using the Thompson method, in which the feldspar is roasted with salt-cake and common salt, and then extracted, yielding over 80%

of the original potash-content of the rock. The work of Mr. A. S. Cushman and Mr. G. W. Coggeshall has also shown great possibilities, employing no more costly reagents than quicklime and the calcium-chloride waste from the ammonia-soda alkali process. It yields a sludge, which is dried and ground, and that contains above 70% of potassium chloride, equal in quality to the imported German muriates. Furthermore, the search for saline deposits capable of supplying potash has resulted in encouraging discoveries, but the policy of the Interior Department in withdrawing potash lands from entry has not only prevented their immediate utilization, but has completely halted the search for more by private individuals. Reported discoveries are subject to immediate withdrawal until Congress shall have legislated for their disposal. Under a restrictive policy of this nature no relief from that source to overcome our existing shortage of potash is to be anticipated. On April 4 Mr. Thomas J. Walsh of Montana in the Senate introduced a bill that bears the ear-marks of the Gifford Pinchot agitation for conservation, which is so conservative as to stifle all hope for the industry. It provides for the issuance of prospecting permits for a period of three years and covering 2560 acres each. As a reward for discovery it would concede a patent to 160 acres, while any portions of the remaining 2400 acres found to be mineral-bearing would be subject to lease under competitive bids, involving a royalty to the Government on the potash recovered in addition to a fixed rental of fifty cents per acre for the first year, payable in advance, and an annual rental of one dollar per acre thereafter. It happens that the prospector is usually a poor man; at best he is a man of very moderate means, and not likely to be in touch with capitalists under relations that would enable him to arrange in advance for the protection of his interests through a corporation prepared to bid in the leaseholds on ground proved by his exploratory work. It is, in effect, an invitation to undertake the hardships of prospecting chiefly for the benefit of others. This assumes a degree of altruism that does not exist in the average man.

The Germans evidently believe that the want of potash means ultimate starvation. In matters of practical science they have shown such astuteness as to compel respect for this opinion. We are looking forward to the possibility of more than a single year of war, and the winning of that war depends upon ample food as much as it does upon guns and explosives. It would be well to cease fiddling with theories of land location, and pass simple practical legislation recognizing the ancient rights of discovery, so as to get results and get them quickly. The Government experts, working in conjunction with the Council of National Defense may be counted upon to see to it that provision is promptly made to save by-product potash from our blast-furnaces and cement plants, but these will not yield all that we need. If other resources of this important alkali exist on the public lands, Congress has a duty to perform in rendering them immediately available.

Labor Troubles at Jerome

Strikes are out of season. We are at war; our national security, our personal liberties are at stake. The Jerome miners seem to have forgotten that they were trifling with their very liberty of organization, and with their exercise of the other rights of freemen, by undertaking to interfere with the output of copper at the present time. Mr. Robert E. Tally, the assistant general manager for the United Verde Copper Company, definitely charged that the local union had been intimidated by the I. W. W. when it voted for the strike, which indicates that the International Union of Mine, Mill, and Smelter Workers is in exceedingly bad company. With organized labor the whole American public is in sympathy; organized labor is today part of our social system, and it has been recognized recently in a most definite manner by the Congress of the United States in putting the Adamson bill on the statute book, and in a still more substantial form that must be gratifying to every patriotic worker by placing Mr. Samuel Gompers in a high position of trust as a member of the Council of National Defense. At Jerome the really important matter, which was the Miami sliding scale of wages, was conceded by the managers, and the men have returned to work.

Unfortunately, the concession was not made until the discrepancy between the scale at Jerome and that at Miami had provoked unrest—an unrest not at all unnatural, seeing that the ore produced by the two principal mines at Jerome is as rich as the concentrate made at Miami. The opportunity for protest was seized by labor agitators of the less scrupulous kind and was made an excuse for further demands, including the check-off system, the grievance committee, and the closed shop. The management of the United Verde erred in judgment in allowing these contentious points to be raised under cover of the wage-scale. As in most labor troubles the main issue is not evident on the surface; in this case, as in the Morenci strike, the opposition of the mine-managers is directed chiefly against the interference of outside organizations. The strike at Jerome was incited from the headquarters of the I. W. W. at Denver, and if that organization is not as infamous as the Western Federation of Miners it yet has a record and a programme that are repellent to good citizens. A grievance committee of their own men should, and would, be acceptable to the local managements at Jerome, but a committee nominated by an outside organization, frankly devoted to fomenting industrial anarchy, is quite another matter. As to the closed shop, that is too big an issue to be discussed as an incident in the Jerome strike. The refusal to recognize the unions is a matter of established policy in Arizonan mining and the present national crisis is not the time to ventilate it. This is no time for labor controversies. Every good citizen must push contentious matters into the background of his mind and give a willing hand to the greater work that has to be done if civilization is to endure and democracy is not to perish.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Sampling Large Low-Grade Orebodies

The Editor:

Sir—Considerable discussion has taken place from time to time regarding the sampling of large low-grade orebodies, and I am pleased to see the subject dealt with by such eminent engineers as J. H. Mackenzie, D. C. Jackling, and H. C. Perkins. I am sure that a free discussion of this important subject by engineers of such experience will be of considerable benefit to metal mining. Having had some experience in sampling high, medium, and low-grade orebodies both in the United States and abroad, I venture to offer a few remarks dealing with this matter.

You say that one man takes a dozen samples, another a thousand, and a third crushes 100,000 tons of ore. I must say that the first man who takes a dozen samples is likely to be as correct as the man who mills 100,000 tons, as, after all, a dozen samples represent a certain proportion of the ore reserves. I do not pretend to say that a dozen samples should in all cases furnish sufficient data upon which to value a mine; at the same time, I have personally secured options on valuable mining properties without taking a sample, but have thoroughly inspected the assay plans, reports of operation and output-results, in addition to which I have selected duplicate samples and had the same assayed as a check against the assay-office results. This method will fit a case where a mine has been a producer and a good record of ore extraction, ore reduction, sampling, assaying and recording of assays, and results generally, has been kept. Further, this method is as likely to prove correct as if the mine is sampled with moil and hammer. In the examination of a mine the examining engineer is as a rule shown through the workings by some one who points out the best places where good ore has been developed, and it is generally advisable to sample the ore that is said to contain certain values as a quick check against the information given. I often ask the vendor to take a sample of the best ore in the mine simply as a check against the information given; this often saves trouble and expense in sampling, as, if the vendor cannot confirm his own story he cannot expect anyone else to do so. The above is another extreme instance and can only be applied to special cases. The sampling of low-grade orebodies, carrying values ranging between $2 and $5 per ton, and expecting accuracy in the determination of ore-reserve value, may lead to disappointment if the sampling by moil and hammer is the only means employed in estimating the value. I may present some details of cases which have come under my personal supervision.

A certain property was taken under option. No great amount of work had been previously done on the property, and what had been done was not recorded, so that it was necessary to start from nothing. The property was 6445 ft. along the strike of the lode-line, which passed over the top of a mountain 1000 ft. high at its greatest elevation. Stations were set 200 ft. apart along the outcrop; trenches were excavated across the lode with pick and shovel, then holes one foot deep were drilled in the hard rock and blasted, thus exposing clean fresh ground. The loose rock was cleaned out and samples cut near the bottom, the width being determined by the formation, that is, the quartz might be 4 ft., schist 3 ft., quartz and schist 5 ft., and so on. These samples were assayed, and an assay-plan prepared by plotting the exact position of the trench, the exact section sampled in feet, the value and the geology. Every sample was thus recorded, and where the first trenches, 200 ft. apart, showed encouraging values a cut was placed between the 200-ft. cuts, and if this latter again confirmed the original cuts then 50-ft. cuts were excavated, and so on, until the cuts over a section showing encouragement were finally narrowed down to 25 ft. apart. Where the original trenches gave no encouragement no intermediate cuts were made, as it was considered unlikely that anything would be found between the 200-ft. cuts. The samples were ordinary samples taken with pick, moil, and hammer and were considered merely as an indication of the probable outline of an orebody or orebodies. Fifteen hundred samples were taken, and 5614 ft. of trenching was made, from which 43,280 cu. ft. of material was removed. The result was so encouraging that an old adit on the vein was cleaned out and extended 2000 ft. into the mountain, the result being that, where values show in the surface cuts, so do values show in the adit at a depth of from 330 to 600 ft. below the surface. A winze has been sunk in one orebody below the adit and levels at 460 ft., and 600 ft. below the surface, confirming the values at the surface.

The determination of the above values was all by the same method, namely, pick, moil, and hammer. Several thousand samples have been taken since, and in order to be sure that the values obtained by sampling could be relied upon there was erected a 3-stamp mill and 18 to 20 tons is being milled daily. Face-samples taken with moil and hammer, car samples, feeder samples, plate tail-samples, and final tail-samples, are all taken as a check on the valuation of the ore reserves. This test is now running and so far it appears to be checking well against the original sampling. I have found that

gold-ore veins, whether high or low-grade, usually carry metal in varying quantities in horizontal planes, the distance between poorer and richer planes being irregular and unreliable. It is a question as to how good the best ore is and how poor the poor ore is, and what proportion one is to the other, that the engineer is confronted with. There are many points to consider when determinig the value of an orebody, the nature of which must be ascertained by the man on the spot who must be familiar with local conditions, the particular orebody, and the human side of the question. It is well to remember that sampling by any method or combination of methods is at best only a rough way of furnishing information upon which the valuation of an orebody may be determined.

I have personally sampled orebodies where the average of the samples taken was 52 oz. per ton of ore, and it would have been misleading to have concluded that the orebody would actually average 52 oz. per ton when the same was stoped. The reason for the high average referred to can be accounted for by the fact that the ore contained heavy gold, and it was impossible to sample the orebody without cutting into the material carrying heavy gold. Instead of stoping operations producing an ore valued at $1000 per ton the average ranged between $40 and $50 per ton. Then again, on a very low-grade undertaking, where the orebody is 48 ft. wide, the average of cut samples with moil and hammer was $2.75, while the cut and car samples averaged $2.90. This same vein was re-sampled in 5-ft. cuts taken on alternate sides diagonally, that is, the first 5 ft. was taken measuring from the hanging wall on the north side; the next sample was taken at 10 ft. from the hanging wall on the south side; the next cut at 15 ft. from the hanging wall on the north side, and so on until the full width of the vein had been sampled. Another crew of samplers began by taking their first cut at 5 ft. from the hanging wall on the south side, the second 10 ft. from the hanging wall on the north side, and so on until the whole of the vein had been sampled, the average being $2.71 as against $2.75 in the original sampling. A drift 80 ft. in length was extended on the foot-wall of the vein, and the average by cuts and car samples in the original work was $3.22. This work was checked by samples taken with moil and hammer by one crew of samplers 10 ft. apart, the average of which was $3.33. Intermediate samples were taken by using a machine-stoper operating a moil; the average of these samples was $3.37. From the same mine 71,424 tons of ore was milled. The value of this ore based upon underground car-samples was $3.90 per ton, and the actual recovery, plus tailing loss, was $3.73, which must be considered a fairly close check on low-grade ore.

In the above details I have tried to show by actual results obtained on mines under my supervision that sampling and determination of values conducted upon the most approved lines, where the sincere object is to guard against unpleasant surprises, was not reliable, and after all only that they formed a basis upon which judgment could be used in the valuation of an orebody. The valuation of an orebody by cut samples only, without making allowance for errors in sampling or wall-rock being broken beyond the point sampled by moil and hammer, is sure to lead to disappointments, and one way to provide for the low-grade material thus broken is to reduce the value of all abnormally high results from cut samples to what is considered by the engineer in charge the amount to which the cut samples shall be reduced. Here, again, enters the human side of the question, which, in my experience, must always be present. One engineer will continually look for faults and discrepancies and generally do a mine more harm by cautious methods than the engineer who sees no great fault in the mine. At the same time the human equation is always present in both types of individuals, and I believe that, if the particular individual handling the undertaking is thoroughly understood, allowance can be made for the results obtained; and if this can be done the result will be just as satisfactory in the one case as in the other. Personally, I think that an enthusiastic engineer is more likely to find something of importance than an engineer who is of a cautious and unresponsive disposition. I firmly believe that engineers make mines and that mines do not always make engineers. This assertion is in direct opposition to the old saying that a good mine makes a good man. My opinion is that a poor mine makes a better man, and, without a good man, there would be no development of low-grade mines and no occasion, furthermore, for estimating the metal contents of low-grade orebodies.

W. J. Loring.

San Francisco, California, May 9.

The Editor:

Sir—I desire to call attention to an article by L. A. Parsons, re-published in your issue of May 26, which appeared originally in *The Mining Magazine*. Its inception was a contribution of mine entitled 'Latent Errors in Mine Sampling' that appeared in *The Mining Magazine* for February 1915. In that article I described five classes of mines, and endeavored to outline the various complications latent in the ore-structure that tend to vitiate sampling. I will quote part of what I wrote because Mr. Parsons criticizes some of my statements under Class 5 by describing his experience in an 'actual case,' which I submit is a type of mine that is not embraced by Class 5 at all, and therefore is irrelevant as a basis of criticism.

The excerpt including the five classes is as follows: "In basing a mine-report on expected output upon sampled areas it should be understood by all concerned that an estimate founded on sampling will remain still an estimate. Irrespective of the experience and care exhibited in the work, the valuing engineer will undertake too much if he assumes that such data embody a statement of fact. The fallibility of an approximation cannot be eliminated, although in cases it may be modified

to meet the necessities of practical requirements. There is a latent error varying with the mineral nature of the ore-structure that it is impossible under practical conditions to control by extreme uniformity in cutting samples and their close adjacency to each other. This error usually indicates a higher metallic content than shown throughout an adequate period of actual ore-treatment, affording data of results in mill-yield, plus residual contents. In the South African banket, the mill-yield plus tailing-content is from 6 to 15% short of the average indicated by sampling. In the premier lead mines of Australia the discrepancy is at least 10%. The results from four well-known gold mines show an unaccounted difference of 12%. These mines are situate respectively in Mexico, Colorado, Australia, and India. In the valuation of a mine, conditions will generally fall under one or more of five classes. After tabulating these as below, I shall endeavor to discuss each in turn. Under practical conditions many of these classes will merge and shade into each other in the same mine; and they are separated here largely to facilitate explanation.

(1) Mines where the average metal-value is mechanically reduced, but where the unaccounted metal may be subsequently recovered.

(2) Mines where there exists an unrecoverable loss.

(3) Mines where sampling indicates a fictitiously high value.

(4) Mines where sampling results in an incorrect subnormal value, conclusive proof being afforded by subsequent commercial results.

(5) Mines where sampling is of no use."

After dealing with the preceding four classes in further detail I then describe Class 5 as follows: "There is a class of mine where the valuable minerals occur in bunches. Under such conditions no confidence can be placed in an assay map, even although an unusually close sampling-interval may have been employed. A level on a certain horizon may pierce a certain number of enrichments which would be represented on the sampling record. Had the horizon of the level been, however, 30 ft. higher or lower, the number of enrichments pierced in the latter case would be out of all proportion to the former. In a mine of this type an attempt to sample blocked out ore would be absurd. The nature of the ore-occurrence would demand a veritable network of levels and raises so adjacent to each other that all hope of a commercial undertaking would be obliterated by the development-charge per ton. Innumerable cases exist where an assay-plan would show the majority of samples as unprofitable, yet, the commercial result has afforded conclusive proof to the contrary. This class is not composed only of precious-metal mines. The base-metal mines of Missouri and the copper mines of Lake Superior are analogous. The only method of reliable valuation in a deposit of this type would be based on an authentic record of past yield, in combination with competently selected representative shipments of the remaining ore."

Why I state that Mr. Parsons is irrelevantly applying an 'actual case' in attempting to criticize my observations under this class, is because he devotes about one page to describe the elaborate painstaking manner in which the various mine-openings were sampled. Had such a programme been applied to a mine properly belonging to Class 5 the sampling result would be a series of 'blanks' on a mine that might continue profitable operations for years. The Tightner mine of Alleghany, in my judgment, is an actual case included in Class 5. The ore essentially occurs in bunches, or like 'plums in a pudding.' The success of the undertaking depends on the importance of the 'plums' when found, and their frequency of occurrence, necessary to offset the dead-work entailed in their search and show a profit. For example, one small stope of less than 9 ft. square produced over $50,000. The vein between the stopes is very low grade, and frequently valueless. In the case of the Tightner mine I am unable to see what would be gained by sampling the intervening spaces. If an engineer did this, and attached any weight to the result, he would probably turn the mine down. In other words, he would commit one of the most difficult mistakes the valuing engineer can live down, namely (assuming the question of price is not entailed), that of turning a good mine down which continues successfully to operate and give the lie to his statements. Also, no tangible object can be gained by sampling one of the 'plums,' which is probably so rich in spectacular gold that more gold is contained in one-half pound of ore, than the average high-grade mine contains in one ton. I therefore submit that there are such mines as I describe under Class 5, and the only competent method of valuation is as that which I attempt to outline.

MORTON WEBBER.

San Francisco, California, May 28.

Value of a Mining Share

The Editor:

Sir—What is it that gives a mining share its market value? Is it the estimated present value of the mine, its potential value, or is it the demand in the market for that particular stock, in case the stock is listed on the Stock Exchange? I have often noticed that the stock of a profitable mine—one that pays dividends regularly—is usually quoted at a price that is evidently considerably above its actual value. Is the market quotation on any mining stock a reliable indication of its real value? To me it seems that it is not so much what a mine has produced in the past as what it can be made to output at a profit in the future that should operate in the public appraisal of the stock.

For a long time I have watched the spectacular rise and fall of Comstock shares, and have observed what to me seems strange, namely, that when a Comstock mine declares a dividend—and they have been known to do so—the stock of that particular mine almost invariably drops a few points. I feel certain that this sudden fall in the market price of shares in a mine under such

auspicious circumstances as the declaration of a dividend is not due to a clear recognition of the fact that the mine has just been depleted of more of its available assets, to the extent of the aforesaid dividend, but must be attributable to some other, perhaps a psychological phenomenon. It is true, a mine that pays a dividend is worth less than before, to the extent at least of the amount of the dividend, but during the time that the ore was being mined that made the dividend possible, work may have been done, resulting in discoveries, the development of which may more than double the visible value of the mine. It is a problem that keeps me guessing.

San Francisco, May 5. A Timid Investor.

What Makes a Good Flotation Oil?

The Editor:

Sir—I have read with interest the papers on flotation, published from time to time in the Mining and Scientific Press, and the opinions it seems permissible to form therefrom are: (1) a mineral with a metallic lustre adheres better to an oiled film than does quartz; (2) air adheres more firmly to a mineral with a metallic lustre than to quartz; (3) the difference of potential between a sulphide-particle and an oiled film is greater than that between a quartz particle and an oiled film; (4) oil makes the film enclosing the air-bubble stronger; (5) the continuous formation of bubbles lifts the oiled solids over the lip of the flotation cell. There appears to be need of a diagram illustrating the difference of potential between the mineral to be recovered and the various mixtures of the flotation-oils most readily available. Any application of physical force to a solid makes it more electro-positive. Hence in the emulsifier of a flotation machine the mutual bombardments of the solid particles impart to them an energy which manifests itself in an increased attraction, however slight, between the solids and the oiled film. The five causes of concentration by flotation mentioned above are the most important, and of these No. 3 and 4 demand the most attention, but in the phenomenon of flotation the degree of fineness of the solid particles in the pulp has also a bearing from the point of view of the grade of the concentrate. Finely ground gangue will be floated with the sulphides. Where the smelter is adjacent to the mill the grade can lie within fairly wide limits, but where transportation charges are a serious factor the grade is of greater importance than the percentage of recovery. For instance, in a South American mill with which I was at one time connected no ores assaying less than 18% copper could be handled profitably before the outbreak of the War, and even with the recent high prices this minimum percentage could be reduced only to 11%. Where a high-grade concentrate is required, I presume that an oil, or a mixture of oils, would be used, which would produce not too profuse and tenacious a froth, and which would have the greatest potential difference. With a feed assaying about 1% copper a certain recovery is effected; with 1.25% copper a higher recovery and a cleaner concentrate is made when the amount of oil added and the volume of air used remain constant. The electrical charges may be represented as follows: the air-bubble —, the quartz +, and the sulphide particle + +. Then, in the case of the richer pulp, as the film becomes more heavily coated with sulphide particles the difference in potential between the quartz and the film will become less, and therefore the tendency for a cleaner separation would become greater. Secondly, as the bubbles are stronger, fewer of the sulphide particles that have once been picked up are dropped. If the difference of potential and the strength of the film-diagrams in a series of two oils were once established, and if at the same time the percentage of recovery were experimentally determined in each case for any sulphide-ore, some light would be thrown on the relationship between these factors in 3 and 4. A research on these lines would be of practical value. A paper, if I remember correctly, had the title 'Why is Flotation.' I should be glad to know just 'Why is a good flotation oil'? Should some of the views I have mentioned be incorrect, I would welcome criticism and correction.

McGill, Nevada, May 4. Paul T. Bruhl.

Home-Made Mine-Haulage Motor

The Editor:

Sir—At the Sinker tunnel, a 7000-ft. adit in Owyhee county, Idaho, the foreman, T. D. Babbit, has constructed a haulage motor, a description of which might suggest to others a utilization of other discarded power-units. An old Detroit electric runabout was purchased, and its 20-hp. motor, control-device, and 60 Edison storage-cells removed and installed in a frame cast to standard shape for storage-battery motors. Power is delivered from the motor by means of chain-belts passing over pinions on the ends of the motor-shaft to cog-wheels on each wheel. The latter are spaced about 3½ ft. centres, and the frame is 10 ft. long. On one end of the frame is a platform for the operator, with the motor-control and handbrake lever within easy reach. The lamps of the runabout are used for headlights. The storage-cells are on top of the frame, and protected by a wooden housing provided with slots for ventilation. The cost complete was $1300, including a mercury-lamp rectifier for charging. It hauls 14 loaded cars, each of 18 cu. ft. capacity, at a speed of 6 to 8 miles per hour. The cost for power delivered at the mine transformer is about 2c. per kw-hr., and the power-charge against the motor is about $6 for 150 ft. of tunnel-advance.

Boise, Idaho, May 17. A. E. Robinson.

Mining in open-cuts is the least expensive of all methods of mining. Where shoveling is necessary, the cost of loading cars should not exceed 20 cents per ton with wages at $2.75 per shift of 8 hours. Where the broken ore can be passed through a grizzly to a chute to be drawn off into cars below, the limit of economy is reached.

Notes on Compression and Transmission of Air

By ROBERT S. LEWIS

Air-compressors are rated by manufacturers on the basis of piston displacement, or volume swept through by the piston, expressed in cubic feet of free air (air under atmospheric conditions of pressure and temperature) per minute. If compressors delivered this quantity of free air as compressed air such a rating would be satisfactory, but various factors modify the intake-capacity of a compressor so that it may be much less than the piston displacement. The ratio of the free air taken into the cylinder to the piston displacement is called volumetric efficiency, and may be expressed in the form of the equation:

$$(1) \qquad E_v = \frac{\text{cu. ft. of free air taken into compressor}}{\text{displacement of compressor in cu. ft.}}$$

The important factors which modify volumetric efficiency are clearance, volume of the piston rod, heating of the air before compressing, leakage of air past the piston and also intake and discharge valves, too small area of valves and the wrong operation of mechanically controlled valves.

The space between the piston, when at the end of its stroke, and the head of the cylinder is filled with compressed air which cannot be discharged. During the return stroke this air must expand until it is at atmospheric pressure before any free air can be drawn into the cylinder. If this clearance space is large, the free-air intake-capacity of the cylinder is materially reduced. In well designed single-stage compressors clearance, expressed as a percentage of the displacement per stroke, is not far from 1% for the large sizes and may be 2% or more for the small sizes of compressors. This means that for a low clearance-value the distance between the piston at the end of its stroke and the cylinder head is only 1/16 or even 1/20 of an inch. The effect of clearance increases as the ratio of compression (final absolute pressure to initial absolute pressure) becomes greater. For large ratios the piston must travel a considerable part of its stroke before any free air can be drawn into the cylinder. If it were possible to compress to 5000 lb. per sq. in. in a single cylinder no air would be taken in during the return stroke. The air in the clearance space, when expanded to atmospheric pressure, would completely fill the cylinder. Assuming that this clearance-air expands isothermally, which is probably more nearly correct than if it is considered to expand adiabatically, the effect of clearance may be calculated as follows:

Let E_c = volumetric efficiency depending upon clearance.

C = clearance expressed as a decimal.

r = ratio of compression = $\frac{P}{P_a}$, P being final absolute pressure in pounds per square inch, and P_a being the initial absolute pressure. (Absolute pressure is gauge-pressure plus atmospheric pressure.)

$$(2) \qquad \text{Then } E_c = 1 + C(1 - r)$$

Thus, when compressing from an atmospheric pressure of 14.7 lb. to 100 lb. as shown on the gauge, with clearance = 2%, then $r = \frac{100 + 14.7}{14.7} = 7.8$, and $E_c = 1 + 0.02\ (-6.8) = 0.864 = 86.4\%$. In case the clearance of a compressor is not known, it can often be determined by measuring the volume of water required to fill the clearance-space. The effect of clearance upon volumetric efficiency is lessened by using stage-compression. Since the air is not compressed to the final pressure in a single cylinder, the percentage of the volume of the low-pressure cylinder occupied by the expanded clearance-air is reduced. The piston rod occupies space on one side only of the piston, consequently the displacement per revolution, corrected for clearance, less the volume of the piston rod, will give the free-air intake-capacity of the compressor per revolution.

Under constant pressure, the volume of a given weight of air is proportional to its absolute temperature (460 + F°). At 60°F., a given volume of air will expand 1/520th of its volume at this temperature for each degree Fahrenheit rise in temperature. If one cubic foot of air at 60°F. is heated to 100°F. as it enters the compressor its volume will be increased 40/520ths, or approximately 8%. In other words a cubic foot of air at 100°F. is equivalent to 92% of a cubic foot of air at 60°F. The power required for compressing a cubic foot of air, once it is in the cylinder, is independent of the temperature of the air. This means that the colder the air is when taken into the cylinder the less will be the number of cubic feet required to give a desired result. For this reason care should be taken to get the air into the cylinder at as low a temperature as possible. The intake-conduit for the compressor should be made of a non-conducting material, such as wood, brick, or concrete, and should draw air from the coolest place available, never from the compressor-room itself. The cross-sectional area of the conduit should be equal to at least one-half the area of the piston in order that the air can flow freely without obstruction. In hot and dusty localities it has been found beneficial to draw air from the interior of a framework covered with burlap or sacking, which is continuously drenched by a spray of water. This procedure not only cools the air, but removes the dust at the same time.

If a compressor has poorly designed intake-passages, the air as it enters the cylinder may be at a temperature several degrees above that of the atmosphere. The metal

of the cylinder becomes quite hot after a compressor has been running for an hour or more, and, after traveling through long and narrow intake-passages, the air may be heated to 100°F. or above.

Let T_c = absolute temperature of the air after entering the cylinder, and T_a = atmospheric absolute temperature, then

$$E_v = E_c \frac{T_a}{T_c} \quad (3)$$

This is the expression for volumetric efficiency modified by clearance and heating of the intake-air.

Leakage past valves and piston will further reduce the intake-capacity of a compressor. If the area of the intake-valves is too small the cylinder will not be filled with air under atmospheric pressure, and, if the area of the discharge valves is too small, all the air will not be discharged. Poppet valves depend upon a difference in pressure on the two sides of from 3 to 5 oz. for their action, and may reduce volumetric efficiency by as much as 2 to 4%. Mechanically operated valves of the Corliss type are very satisfactory, but they must be maintained in correct adjustment. Though the effect of clearance, and of heating the air before compressing, can be calculated by the formulas it is well to bear in mind that the results so found may not always agree with the actual conditions of operation. The leakage of air past valves and piston, the choking of air-passages, and bad valve-action, are variables that cannot be determined by formulas. Volumetric efficiency is most accurately computed by measuring the air delivered and comparing it with the displacement of the compressor. Such a method includes all factors affecting the performance of the machine.

When the ratio of compression is large the final temperature of the air in the cylinder may be very high. The relation of temperature to volume and pressure is given in the following equation:

$$T_2 = T_1 \left(\frac{V_1}{V_2}\right)^{n-1} \quad (4)$$

$$T_2 = T_1 \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}} \quad (5)$$

The subscripts 1 and 2 indicate initial and final conditions respectively. P and T are in terms of absolute pressure and temperature. Volumes V are in cubic feet. The value of n for perfect adiabatic compression is 1.406. For an initial temperature of 60°F., a final gauge pressure of 100 lb., and atmospheric pressure of 14.7 lb., the final temperature of the air would be

$$T = (460 + 60)\left[\frac{14.7 + 100}{14.7}\right]^{0.29} = 520(7.8)^{0.29} = 931° \text{ abs.} = 471°\text{F.}$$

Should some of the hot compressed air leak back into the cylinder, or should the ratio of compression be increased by throttling of the intake-air through sticking of the valves, the temperature may be even higher than the above theoretical value. That such high temperatures are reached in practice is shown by the explosions that occasionally take place in compressors and receivers. An air cylinder, unlike a steam cylinder, requires only a small quantity of oil, a drop once in four or five minutes should ordinarily be sufficient. The use of too much oil causes an accumulation of carbon that may choke the valves and passages. Kerosene, often employed for cleaning valves, has a flash point of 150°F. or less, and ordinary lubricating oils have flash points varying from 330° to 425°F. In view of the high temperatures that may be reached in the cylinder, such oils are obviously a source of danger. Only a thin air cylinder oil, with a flash point of 600° to 630°F., should be used. For cleaning valves, a mixture of soft soap and water should be fed through the lubricating cups once or twice a week. As a safety measure, it is advisable to place a thermometer or fusible plug in the discharge pipe, and as near the compressor as possible.

For pressures up to 75 lb. per sq. in. single-stage compression is satisfactory, but for pressures from 75 to 150 lb., which are commonly used in mining work, two-stage compression is preferable. The ratio of compression in a cylinder of a two-stage compressor is equal to the square root of the ratio of compression in a single-stage compressor delivering air at the same final pressure; consequently losses in capacity due to clearance and leakage are materially lessened. The inter-cooler of a two-stage compressor will reduce the temperature of the heated air from the low-pressure cylinder nearly to that of the atmosphere before it enters the high-pressure cylinder; therefore the final temperature of the air is lower than for single-stage compression, and lubrication is facilitated. However, the sticking of valves, or the choking of passages, may cause such a high temperature to be reached in the high-pressure cylinder that an explosion will occur, even in a compound compressor.

The theoretical work of compression may be easily calculated with the aid of chart No. 1, constructed by the Nordberg Manufacturing Company.

Curve *a* is for isothermal or ideal compression.

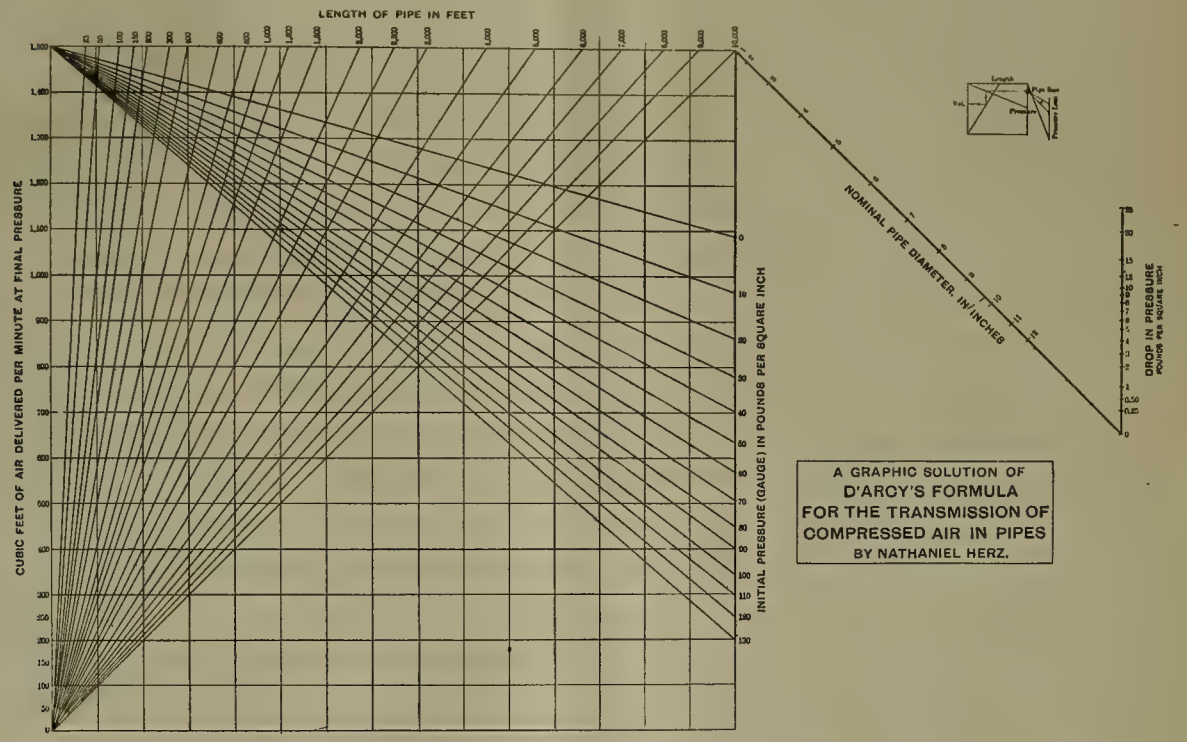
Curve *b* is for three-stage compression.

Curve *c* is for two-stage compression.

Curve *d* is for single-stage or adiabatic compression.

First compute the ratio of compression. Find this figure on the bottom scale and project vertically to intersect the curve for the given method of compression. From this point pass to the left margin and find the horse-power required per pound of atmospheric pressure. Multiply this figure by the atmospheric pressure, and the result will be the theoretical horse-power required to compress 100 cu. ft. of free air. What is the horse-power required for compressing 500 cu. ft. free air from 11 lb. atmospheric pressure to 110 lb. gauge-pressure, two-stage compression? Here $r = \frac{(110 + 11)}{11} = 11$, and for curve *c* the air horse-power is 1.25. Multiplied by the atmospheric pressure of 11 lb. this gives 13.75 hp. for 100 cu. ft. free air, or 68.75 hp. for 500 cu. ft. The advantage of this chart lies in the fact that it is applicable to compression at any altitude. The actual horse-power required will be slightly less than that given by the chart for adiabatic or single-stage compression,

and a little greater than that given for two and three-stage work. Full adiabatic compression, or compression with no loss or gain of heat from any outside source, cannot be attained in practice because compressors are water-jacketed and have some cooling effect on the air. The inter-cooler used in stage-compression should cool the air to the temperature of the atmosphere, but this efficiency is not reached. Atmospheric pressure varies with the altitude at which it is measured. Its value at sea-level equivalent to a cubic foot of air at the given altitude is $\frac{P_a}{P_s}$. For an elevation of 8000 ft. this ratio is $\frac{11}{14.7} = 75\%$. This means that every cubic foot of air at 11 lb. pressure is equivalent to only 0.75 cu. ft. of air at sea-level. Since a compressor, operating at a high altitude, will deliver less air than if operating at sea-level, its power-consumption must be less, but power-consump-


LENGTH OF PIPE IN FEET
CUBIC FEET OF AIR DELIVERED PER MINUTE AT FINAL PRESSURE
INITIAL PRESSURE (GAUGE) IN POUNDS PER SQUARE INCH
NOMINAL PIPE DIAMETER, IN INCHES
DROP IN PRESSURE POUNDS PER SQUARE INCH
A GRAPHIC SOLUTION OF
D'ARCY'S FORMULA
FOR THE TRANSMISSION OF
COMPRESSED AIR IN PIPES
BY NATHANIEL HERZ.

any elevation may be found by either of the following equations:

(6) $$\text{Log } P_a = 1.1673 - \frac{h}{122.4\,T}$$

(7) $$P_a = 0.4931B(1 - 0.0001\,(F - 32))$$

Where h = altitude in feet.

T = absolute atmospheric temperature (460 + F°).

P_a = atmospheric pressure, pounds per square inch.

F = Fahrenheit temperature in degrees.

B = barometer in inches.

Thus for an elevation of 8000 ft. and a temperature of 60°F., $\text{Log } P_a = 1.1673 - \frac{8000}{122.4\,(520)} = 1.1673 - 0.1257 =$ 1.0416, or the log of 11 as the nearest number.

The effect of lessened atmospheric pressure on a compressor is to reduce the quantity of air delivered, as compared with operation at sea-level. With constant temperature the volume of a definite weight of air varies with the absolute pressure. If P_s = absolute (atmospheric) pressure at sea-level = 14.7, the percentage at tion does not fall off as rapidly as the capacity is reduced. The ratio of compression for 100-lb. gauge at 8000 ft. elevation is $\frac{(100 + 11)}{11} = 10.1$, as against 7.8 at sea-level. A greater ratio of compression means a higher final temperature for the air in the cylinder, and this requires more power for compressing. The heated air tends to expand and thereby offers greater resistance to the piston. At an elevation of 15,000 ft. the reduction in capacity, when compared with conditions at sea-level, is about 42%, but the decrease in power required is only about 25%.

The weight of a cubic foot of air at any pressure and temperature can be found by means of the formulas given below.

(8) $$w = 2.708\left(\frac{P}{T}\right)$$

(9) $$w = 1.325\left(\frac{B}{T}\right)$$

where w = weight of air in pounds per cubic foot.

P = absolute pressure.

T = absolute temperature.

B = barometer in inches.

The weight of a cubic foot of air at sea-level and 60° F. $= 2.708 \left(\frac{14.7}{520}\right) = 0.0766$ lb., and at 8000 ft. elevation $= 2.708 \left(\frac{11}{520}\right) = 0.0572$ pounds.

When calculating the free-air requirements of rock-drills, it is necessary to reduce quantities to equivalent cubic feet of free air at sea-level, a figure usually given by manufacturers in their catalogues. For drills operating at sea-level, but under different pressures, the ratio of the cubic foot of free air consumed would be equal to the ratio of the final absolute pressures used. Thus, for a drill consuming 80 cu. ft. of free air at 90-lb. gauge, the final absolute pressure is 104.7 lb., and for a similar drill operating at 100-lb. gauge, the final absolute pressure is 114.7 lb., and the ratio of two is $\frac{114.7}{104.7} = 1.19$. The second drill requires $80 \times 1.19 = 95.2$ cu. ft. free air. In case it is desired to determine the free-air consumption of a drill operating at 90-lb. gauge and at an elevation of 8000 ft. use the equation.

$$(10) \qquad R = \frac{p_a(P_a + P_g)}{P_a(p_a + p_g)}$$

where R is the ratio of free-air consumption at a given altitude to that at sea-level. The small letters are for sea-level conditions, the capitals are for conditions at any elevation, and the subscripts are for atmospheric and gauge-pressures respectively. For the first drill mentioned above, $R = \frac{14.7(11+90)}{11(14.7+90)} = 1.19 \times 80 = 103.2$ cu. ft. of free air required at 8000 ft. elevation to equal 80 cu. ft. at sea-level.

An all too common cause of loss of power in the use of compressed air is caused by the installation of pipe-lines of too small a diameter. Even though the main air-line may be large enough, the branch lines and pipes to the drills are often so small that a 10 to 25% loss in power is experienced. In order to keep friction-losses within a reasonable limit, the velocity of the air should not exceed 20 to 25 ft. per second. If a 3-in. piston-drill were supplied with air through a 1-in. pipe, the velocity of the air would be over 50 ft. per second, and the resultant drop in pressure would be nearly 10 lb. for a 100-ft. length of pipe. On the other hand as an example, two drills were supplied with air through a pipe-line 10,000 ft. long in which the velocity of the air was only 3.5 ft. per second. The total drop in pressure was only 0.002 lb. Chart No. 2 shows the loss in pounds for 100 ft. of pipe when conveying air at 90-lb. gauge-pressure through small pipes. Evidently it is better to use a 1¼-in. or a 1½-in. pipe than the 1-in. which is often installed. In Vol. 44, Trans. A. I. M. E. (1913), Nathaniel Herz gives a graphic solution of D'Arcy's formula for computing the size of air lines.

$$(11) \qquad V = c\sqrt{\frac{d^5(p_1 - p_2)}{wL}}$$

V = cubic feet compressed air delivered at final pressure.

c = experimental coefficient.

d = diameter of pipe in inches.

L = length of pipe in feet.

w = weight in pounds per cubic foot of air at pressure p_1.

p_1 and p_2 = initial and final gauge-pressures respectively.

TABLE OF VALUES OF c

Size of pipe	Value of c	Size of pipe	Value of c
1-in.	45.3	7-in.	60.3
2-in.	52.6	8-in.	60.7
3-in.	56.5	9-in.	61.0
4-in.	58.0	10-in.	61.2
5-in.	59.0	11-in.	61.8
6-in.	59.8	12-in.	62.0

Chart No. 3 gives a graphic solution of this formula. To use the chart, find on the left hand margin the quantity of compressed air to be delivered, then pass horizontally to the diagonal line for the length of pipe-line, project vertically to intersect the diagonal for the initial gauge-pressure, then across horizontally to the right to the heavy vertical line upon which the initial gauge-pressures are printed. Use this point as a pivot, and swing a straight-edge to cut the lines for size of pipe and the drop in pressure. The pressure-drop in various sizes of pipes can thus be quickly ascertained. The cubic feet of compressed air to be delivered is found by dividing the cubic feet of free air required by the ratio of the final absolute pressure in the pipe to the atmospheric pressure. If the drop in pressure is large, it may be advisable to re-calculate the cubic feet of compressed air delivered. The method of using the chart may be reversed to find the maximum volume of air that may be handled in a given line.

In order to have a number of branch lines equal in carrying capacity to a main line, it has been found that the pipes should be to each other as the square root of the fifth power of their diameters.

RELATIVE CARRYING CAPACITIES OF PIPES

Size	1	1¼	1½	2	2½	3	3½	4	4½	5	6
1	1.0	0.48	0.27	0.14	0.07	0.05	...	...	...	...	...
1¼	2.1	1.0	0.55	0.29	0.16	0.10	0.06	...	...	...	...
1½	3.7	1.8	1.0	0.53	0.29	0.18	0.11	0.08	...	..	..
2	7.14	3.4	1.9	1.0	0.53	0.33	0.21	0.14	0.10	...	..
2½	13.4	6.3	3.5	1.9	1.0	0.63	0.40	0.27	0.20	0.15	...
3	21.4	10.3	5.7	3.0	1.6	1.0	0.67	0.43	0.32	0.23	0.15
3½	...	16.1	9.0	4.7	2.5	1.5	1.0	0.68	0.50	0.38	0.23
4	...	...	13.1	6.9	3.7	2.3	1.4	1.0	0.71	0.56	0.34
4¼	...	...	...	9.6	5.0	3.1	2.0	1.4	1.0	0.77	0.47
5	...	...	...	...	6.7	4.4	2.6	1.8	1.3	1.0	0.63
6	...	...	...	...	...	6.5	4.3	2.9	2.1	1.6	1.0
7	...	...	...	...	...	...	6.5	4.4	3.2	2.4	1.5
8	...	...	...	...	...	...	...	6.5	4.7	3.5	2.2
10	...	...	...	...	...	...	...	...	8.3	6.3	3.9
12	...	...	...	...	...	...	...	...	...	10.3	6.3

The efficiency of a well designed pipe-line may be seriously diminished by leaks. Compressed air, under as low a pressure as 13-lb. gauge, will escape into the atmosphere with a velocity of over 1000 ft. per second, and seemingly small leaks will often cause a serious loss of air. At one mine it was found that the compressor-installation was apparently inadequate for the work required. Before ordering more compressors the pipe-lines were carefully examined and all leaks were stopped. The surprising fact was developed that more than 500

hp. had been saved by repairing the air-lines, and the compressors in use could easily meet the legitimate demand made upon them.

When pipe-lines are being constructed care should be taken that white lead or other cementing material is not used in such excess that it is forced into the pipe, thereby obstructing the passage of the air. All joints should be tightly screwed together, and blow-off or drain-valves should be placed at low points so that accumulated water can be drawn off. A pipe-line can be put together so that no noticeable leakage will occur. One of the longest lines in the world, 120 miles in length, is said to have been perfectly tight under a pressure of 600 pounds.

Loss of power is not synonymous with loss of pressure. Where there is a decrease in pressure there is an increase in volume, and the resultant power-loss is less

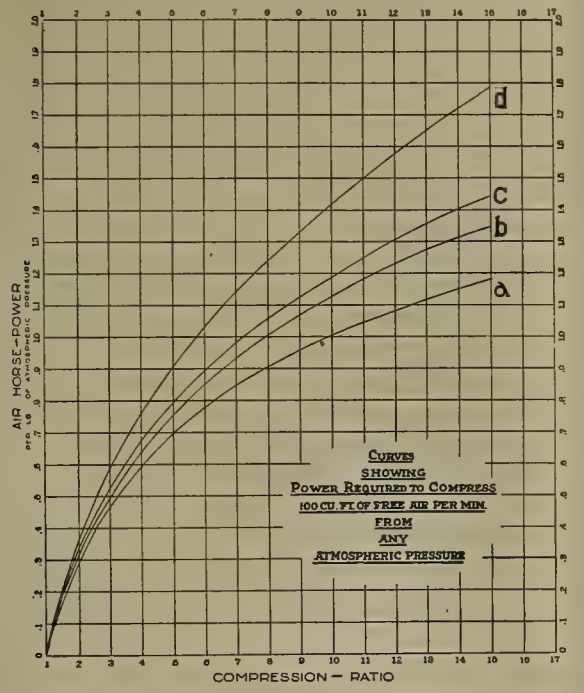


CHART No. 1

than the loss of pressure. Since the air in a transmission line is at atmospheric temperature, the assumption that it will expand according to isothermal laws is justifiable. The power in the air entering the pipe is therefore $P_1 V_1 \log_e r$, and at the end of the line it is $P_2 P_2 \log_e r_2$, and the efficiency of the transmission of power equals the ratio of the two quantities. Now $P_1 V_1 = P_2 V_2$ and, together with the base e, can be eliminated from the expression. The efficiency of transmission is then

$$(12) \qquad E = \frac{\log r_2}{\log r_1}$$

where r_2 and r_1 are the ratios of compression at the discharge and intake-ends of the pipe respectively.

Example: what diameter should be used for a line that is to transmit 4000 cu. ft. free air per minute, compressed to 90-lb. gauge, with a loss of not more than 5% of its energy, atmospheric pressure being 13 lb. and the line being 1200 ft. long? Here, $E = 95\%$ and $r_1 = 7.9$. Log $r_2 = 0.95 \times \log 7.9 = 0.852745$, or $r_2 = 7.1$. Final pressure is therefore $13 \times 7.1 = 92.3$ lb. absolute $- 13 =$ 79.3 lb. gauge, and the drop in pressure is 10.7 lb. The cubic feet at final pressure $= \frac{4000}{7.1} = 564$, and from chart No. 3 the size of pipe to be used is 5¾ in., or a 6-in. line.

The cubic feet of free air required by various sizes of

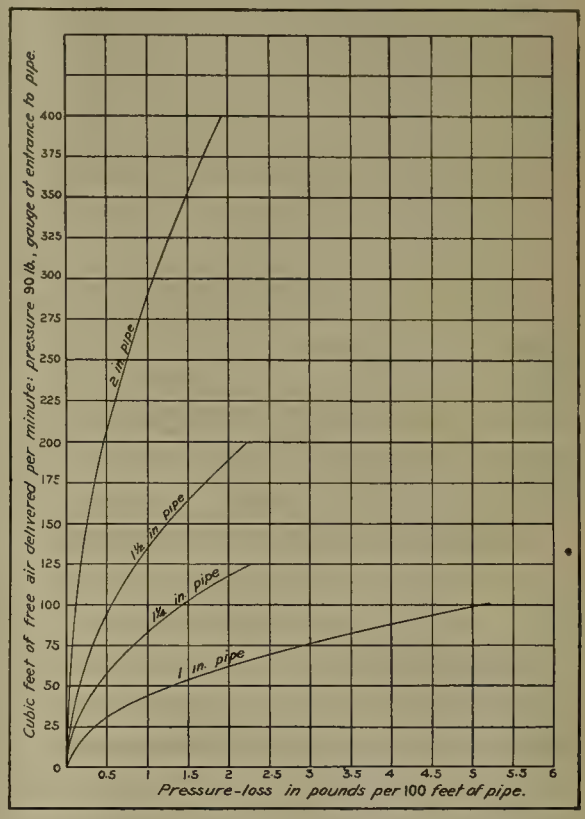

Cubic feet of free air delivered per minute; pressure 90 lb., gauge at entrance to pipe
2 in. pipe
1½ in. pipe
1¼ in. pipe
1 in. pipe
Pressure-loss in pounds per 100 feet of pipe.

CHART No. 2

rock-drills is given in the accompanying table. The figures represent good average practice.

Cubic feet of free air required by piston-drills at sea-level. Pressure, 90 lb. gauge.

Size of drill, in.	2	2¼	2½	2¾	3	3¼	3½	3⅝	4¼	5
Cu. ft. per minute	70	87	95	118	126	140	152	160	210	250

Hammer-drills require from 15 cu. ft. for light work, such as hitch-cutting, to 65 or 80 cu. ft. for the large sizes. In a mine using a large number of drills, all the drills are never running at the same time. A factor for estimating the number of drills that would probably be in operation at the same time is as follows:

Number drills	2	3	4	5	6	7	8	9	10
Factor	1.8	2.7	3.4	4.1	4.8	5.5	6.1	6.7	7.3
Number drills	11	12	15	20	25	30	35	40	
Factor	7.8	8.4	10.3	12.8	15.1	17.3	19.7	22	

The air-requirements of different drills vary so that it is advisable to have some means of measuring the air actually used. A simple and sufficiently accurate method of determining the cubic feet consumed is to use two steel tanks from 2 to 3 ft. in diameter and from 4 to 6 ft. high. The tanks are placed close together, and the bottoms are connected by a 3 or 4-in. pipe. A pipe is run from the top of each tank to a four-way valve, which is also connected to the air-main and to the line running to the drills. A water-glass should be placed on the outside of each tank. Marks should be placed on these glasses at the top and bottom so that the tanks can be filled and emptied to these marks and the volume, in cubic feet, required to do this can be calculated. Both tanks should be provided with pressure-gauges. To use the tanks, first fill them half full of water. Air from the supply-line is then admitted through the four-way valve until the water in one tank is lowered to the bottom mark; the other tank is then full of water. The valve is now reversed and air is admitted to the second tank, forcing water into the first one and displacing the air contained, which goes out through the valve to the drills. The cubic feet of compressed air required can be calculated from the number of times the tanks are filled and emptied. The equivalent cubic feet of free air can be determined from the equation $v = \frac{PV}{p}$, where v is the required volume of free air, p is atmospheric pressure, P equals absolute pressure in tanks, and V is the volume of compressed air handled.

Method for Treating Impure Tungsten Ore

By WILL BAUGHMAN

A year ago practically any kind of tungsten ore found a ready market. This so stimulated the search for tungsten deposits that the supply soon responded to the demand, and the old requirements of a high percentage of tungsten tri-oxide and freedom from impurities were re-established. Certain Arizonan and Bolivian wolframite concentrates contain elements that are considered objectionable by tungsten ore buyers. Both of these concentrates also contain considerable silver. I supervised extensive experiments in chloridizing roasting and then leaching the concentrate to extract the silver with thiosulphate solution. These experiments were fairly successful, but the tungsten residue was still penalized $2 per unit. Such a deduction means $120 per ton of concentrate, therefore the removal of the impurities is to be desired. I finally worked out a successful method of procedure. It was positive in action and few impurities can follow through, as is the case with any alkali-fusion process. Furthermore, the impurities are recovered in a commercial form.

The equipment consists of a stoneware digester, two gas-fired evaporators, and ammonia-vapor condenser, storage tanks for ammonia, acid, and brine, two stoneware injectors, an absorption tower, and a retort used in the regeneration of acid. The process as applied to the Bolivian concentrate, which is very impure, is as follows: The concentrate is digested in strong hydrochloric acid, containing a little nitric. Steam is used for heating and agitation. The period of treatment generally lasts 4 hr. or until most of the iron and manganese are dissolved. The acid solution is filtered off, and should any gold or bismuth be present, as is the case with some Arizonan ores, hydrogen sulphide is passed through to precipitate them. The solution is then evaporated and solid ferrous chloride is charged into the retort where it is heated in the presence of steam and air, converting the manganese and iron into oxides and evolving hydrochloric and nitric acid vapors. These vapors are caught in a vitrified pipe absorption-tower filled with coke. The tower-solution is kept in constant circulation by a stoneware injector. The tower-sump also acts as a solution-storage tank. About 75% of the hydrochloric and 50% of the nitric acid are regenerated. Additional acid is added to keep the solution as it accumulates up to the required standard.

The ore is next leached with a strong hot salt-brine. This brine is sufficiently heated by the steam that operates the injector used for elevating the brine from its storage-tank to the digester. The brine dissolves the silver in the ore. The solution is then run through precipitation-boxes of identical design with those used in cyaniding. Iron scrap and turnings are used for precipitation of the silver. From the precipitation-boxes the solution runs to the storage-vat.

The residue in the digester is next thoroughly washed with hot water which is run to waste. Next the residue is digested with ammonia for dissolving the tungsten tri-oxide. This liquor is evaporated, the ammonia-vapor being led to the condenser and recovered. When all the free ammonia is boiled off the cover is removed, and as the ammonium tungstate crystallizes out of the concentrated solution it is dipped up. This ammonium tungstate is over 99% pure, and is a commercial product.

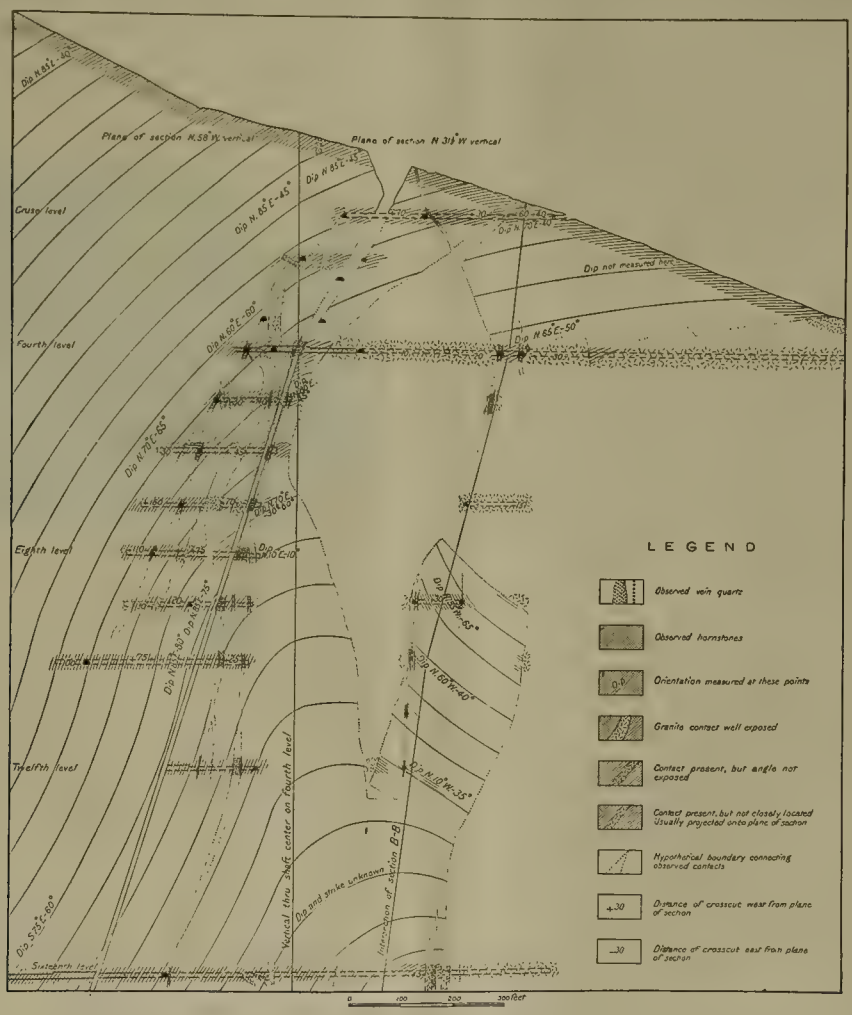
The residue in the digester consists of silica, tantalite, cassiterite, and some undecomposed wolframite. About 100 lb. of residue remains when treating Bolivian concentrate. It is worked up in the laboratory according to standard methods for recovery of tantalum and tin compounds.

This process is not adaptable to the treatment of a large tonnage, nor would it be suitable for treating high-grade ore. Its field is properly the treatment of impure ore. The tungsten tri-oxide, being 99% pure, brings a higher price than the same amount would bring if combined with other substances. A recent number of the Mining and Scientific Press quotes $16.50 per unit for impure concentrate and $18 for pure ores. This is a difference of $90 per ton of 60% concentrate. The cost of treatment by the method described is considerably less than this figure, and the product will bring a proportionately higher figure. The method practically follows one method of analysis for tungsten ore so that the extraction is practically complete.

Revival of Mining at Marysville, Montana

By L. S. ROPES

After a long period of practical stagnation, Marysville has assumed an activity that seems to assure an indefinite future of prosperity through the re-opening of a number of the old mines and the development of prospects long awaiting the touch of capital. With a record of $50,000,000 produced in the past, and no failures among the earlier operators, it is surprising that the camp has been idle so long. Potent factors in the re-opening of the camp are, first, the reversion of capital to prospects and to old mines; second, the entrance into Deer Lodge of the power-lines from Great Falls, with power for a district that had been depleted of its supply of fuel through the earlier period of prosperity; and, third, the proving of the old and long-known Shannon prospect. These, with the advent of the Barnes-King Development Co., upon its purchase of the Piegan-Gloster group, and the later acquisition of the Shannon mine, for the proving of which the company paid a premium of $200,000 over the purchase price, have attracted the attention of investors. The Gloster and Shannon are now in active production, and a mill of approximately 150 tons daily capacity is turning out from $50,000 to $75,000 per month. The St. Louis Mining & Milling Co. has been re-opening the Drumlummon mine, the mill being completed, with an installation of motors for electric drive, and it is now commencing operations.


Plane of section N.58°W. vertical
Plane of section N.31°W. vertical
Crust level
Fourth level
Eighth level
Twelfth level
Sixteenth level
Dip not measured here
Vertical thru shaft center on fourth level
Dip and strike unknown
Intersection of section B-B'
LEGEND
Observed vein quartz
Observed hornstone
Orientation measured at these points
Granite contact well exposed
Contact present, but angle not exposed
Contact present, but not closely located Usually projected onto plane of section
Hypothetical boundary connecting observed contacts
+30 Distance of crosscut west from plane of section
-30 Distance of crosscut east from plane of section
0 100 200 300 Feet

SECTION THROUGH DRUMLUMMON MINE, MARYSVILLE

This mill is of 125 tons capacity per diem. During the year, the Marysville Gold Mining Co., organized originally on the strength of the Annie Dillon property, has taken over several groups of claims, including the Blue Bird, Hickey, Mt. Pleasant, and Honey Comb mines, each having a small production to its credit, and it has been developing these for several months. The results attained have justified the belief in its possibilities. The re-openeng of the Blue Bird, closed and inaccessible for 20 years, explodes the theory that a mine in such a state breeds only fairy tales and myths. Cross-cuts and other exploration have already revealed unsuspected orebodies. Similar work in the Honey Comb has brought to light a previously unknown vein, which promises to become more important than the original mine. The Barnes-King Development Co. has secured an option on the Boyer property, a recent discovery that has given good results, which suggests that all the veins and lodes of the district have not yet been disclosed.

Marysville has been essentially a free-milling district. Crushing with stamps, amalgamation, and vanner-concentration, was customary. The St. Louis will follow the latter practice, while the Gloster mill is obtaining satisfactory results by all-sliming and cyanide agitation direct, without supplementary amalgamation or concentration. Owing to valuable sulphides in some of the ores, direct cyanidation will not be permissible, but a high recovery will be possible by flotation and cyanidation. Ores of this kind lead to a consideration of the lead-copper-silver deposits with only nominal gold-content, which have been prospected for years. Some of these prospects date back to the original location of the gold mines, when it was hoped that shipping or free-milling gold ore might be found. Around the margin of the gold-bearing area are a number of promising developments on such ores.

The Marysville district is an area of metamorphosed slates with interbedded micro-diorite sheets surrounding and overlapping a central exposure of quartz monzonite. These are cut by dikes of diorite porphyry. The contact of hornstones and granite, the terms locally used for the principal formations, varies from a vertical to a horizontal position, as also do the bedding-planes of the hornstone. The geology of the region has been given in Professional Paper No. 57 by Joseph Barrell, and also in Bulletin 527 of the U. S. Geological Survey, prepared by Adolph Knopf. The veins of the Marysville district vary from a few inches of bonanza-ore to others several feet in width, and there are also shear and breccia-zones from a few feet to 30 and 40 ft. wide, occurring in the monzonite and in the hornstone. Though not contact-veins, they may (as seen in the Drumlummon mine) follow closely along the vertical contact, and within one or the other formation, or they may strike transversely to the contact, as is the case with the Empire North Star vein of the Drumlummon, and with the veins of the Belmont, Bald Mountain, Gloster, Annie Dillon, and Spokane contacts of flatter position, while another series, remote from the exposures of the monzonite, appear directly related to the diorite-porphyry dikes. The strike of the latter veins is at sharp angles with that of the dikes which they penetrate, in some cases crossing into the porphyry, or hornstone, without decrease of metal-content. The Bald Butte is one of this kind, yielding 50% of its gross yield of $3,500,000 in dividends; others of the same class are the Penobscot and Bell Boy, on the same dike, the Shannon on the west dike of the Mt. Pleasant area, the Blue Bird and the Honey Comb on the Blue Bird dike, and the Mt. Pleasant and Emma Miller on the Mt. Pleasant dike. The last, which constitutes the East dike, follows the granite-contact for several hundred feet to the east. Either class appears to be a case of fissuring and shearing due to shrinkage, with subsequent mineralization, in the monzonite or the

DRUMLUMMON HILL, NEAR MARYSVILLE, MONTANA

diorite porphyry, as the case may be, the mineralization probably being related to the porphyry dikes, as similar dikes are observed to cut the monzonite. Veins within the monzonite yield mostly gold, while in others the silver at times runs into hundreds of ounces per ton. Manganese is a prominent feature in some of the veins. Where it occurs low assay-values will be found in the upper zones of the lodes. This was noticeable in the Shannon and the Blue Bird mines, lying along the same lode, and also in other mines of the district. To this is attributed the rich zones of gold ore in such mines. The influence of manganese on the secondary enrichment of gold veins, discussed by William H. Emmons in Bulletin 529 of the U. S. Geological Survey, brings out these characteristics of the Marysville area. The outcrop in these cases rarely assays over $1 per ton in gold, and the average prospector, not comprehending the fact that veins are not as they were made at the beginning of the world, as a rule passed them by. This is not surprising when even some engineers of intelligence seem uninformed as to such occurrences, and fail to see the significance of manganese in a splendid, though shallow exposure, and discourage deeper development. These enrichments are common in the Marysville mines.

Theory of Ore Flotation

By H. P. CORLISS and C. L. PERKINS

*The physics and chemistry of ore flotation constitute the subject of extensive literature, but no one contribution presents an explanation of all the physico-chemical factors involved. These articles[1] include collectively considerable information of importance, but have failed to elucidate this very obscure problem.

In this paper is presented an explanation of the actual factors involved in ideal flotation and also of other practical observations incident to the art. The theory presented herein has been substantiated by actual experiment, but only a brief résumé of the experimental results is included.

The greatest success in the art has been obtained in processes in which a gas, usually air, is introduced into the pulp, either by chemical means from carbonate and acid (Potter-Delprat process), assisted by vacuum (Elmore process), by the use of agitation (Minerals Separation process), or by blowing it in through a porous blanket (Callow process), and with or without the use of oil. The explanation offered in this paper is for this type of process especially, although the simple flotation-principles involved in such processes as the Maquisten, the Wood, and the bulk-oil process, are included. In all these processes the material floated must not be wholly wet by the water or solution in the presence of this gas or the material surrounding this gas, for example, an oil-film on the bubble-surface. If the material is completely wet by the water, it will not float, which is the case of the ideal gangue, while the material floated must go to the interface water-air bubble or entirely into the phase other than water, that is, the oil on the air-bubble.

The relations of the forces acting to produce this result were first stated by Freundlich[2], and enlarged upon by Hoffman[3] and Reinders.[4] They were first stated for the behavior of a sol, which will be called disperse phase 3 in liquid 1, when shaken with an immiscible liquid 2. Let

$T_{1\ 3}$ = interfacial tension between phase 3 and liquid 1,
$T_{2\ 3}$ = interfacial tension between phase 3 and liquid 2,
$T_{1\ 2}$ = interfacial tension between the two liquids.

If $T_{2\ 3} > T_{1\ 3} + T_{1\ 2}$ the sol will remain unchanged:

If $T_{1\ 3} > T_{2\ 3} + T_{1\ 2}$ the disperse phase 3 will go entirely into liquid 2;

If $T_{1\ 2} > T_{2\ 3} + T_{1\ 3}$ the disperse phase will collect at the liquid-liquid interface and will, if possible, separate the two liquids from each other.

If, however, no one interfacial tension is greater than the sum of the other two, then the disperse-phase will collect at the liquid-liquid interface, but the three phases will meet at a certain contact angle. The application of these principles to flotation may now be stated, for while the greater part of the material floated is much less disperse than that which is considered colloidal, the interfacial tendencies are the same, it simply being a question whether the forces holding the mineral to the interface are sufficient to overcome gravity, if the particle is to float.

Methods of flotation without resort to the use of oil are exemplified in the well-known Potter-Delprat process, in which CO_2 is generated in the acid pulp, but may be carried out successfully on some ores in a Callow cell, using air. Here, if flotation is to result, the mineral must go to the interface water-gas and be carried at this interface to the top of the pulp. The word water will be used mostly to denote the aqueous phase, whether it is pure water or a solution, and the flotable material will be called sulphide, since this is the common case. On the basis of interfacial tensions, where if

$T_{s\ a}$ = interfacial tension sulphide-air (or CO_2),
$T_{s\ w}$ = interfacial tension sulphide-water,
$T_{w\ a}$ = surface-tension water-air (or CO_2),

either (1) $T_{s\ w} > T_{s\ a} + T_{w\ a}$ or (2) no one interfacial tension is greater than the sum of the other two, must be true. It is obviously impossible to have $T_{w\ a} > T_{s\ a} + T_{s\ w}$ as the latter two are very large in comparison with the first, according to theoretical reasoning and measurements.[5] Case 2 is the actual one, as can be seen if a drop of water is placed on a flat sulphide surface. Here the water does not spread over the entire surface, but comes to equilibrium with the three phases, sulphide, air, and water in contact at a certain angle. Case 1 would require that the water should not wet the sulphide at all in the presence of air. In flotation then the sulphide comes to the air-water interface and sticks through the bubble-surface to a certain extent, or is held in such a way that the three phases are in contact. The gangue material is completely wet by water and does not float, that is, $T_{g\ a} > T_{g\ w} + T_{w\ a}$.

Some measurements were made to get an idea of these

Jour. Ind. & Eng. Chem., May 1917.

[1] See especially the following: W. D. Bancroft, *Jour. Phys. Chem.*, 19 (1915), 275; Ralston M. & S. P., Oct. 23, 1915; Callow, Bull. A. I. M. E., Dec. 1915, 2321; Anderson, *Ibid.*, July 1916, 1119; and Taggert and Beach, *Ibid.*, Aug. 1916, 1373. For a very complete bibliography, see School of Mines & Metallurgy, Univ. of Missouri, Bull. 8, No. 1, 1916; also Bull. A. I. M. E., 1916, 1131.

[2] 'Kapillarchemie,' 1909, 137, 174.

[3] *Zeit. phys. Chem.*, 83 (1913). 384.

[4] *Kolloid Zeit.*, 13 (1913), 235.

[5] Hulett, *Zeit. phys. Chem.*, 37 (1901), 385. Also the surface-tensions of molten metals and fused salts are high.

interfacial tendencies, by a method explained in connection with Fig. 1. Here a flat-ground mineral-surface was placed vertically in water or other solution as shown. By raising and lowering the mineral, a quite constant result was obtained for the rise of the meniscus against the mineral above the general level. Here the meniscus was always upward, showing a greater preference of the mineral for water than for air. In the case of the sulphides, when they were raised, the meniscus would soon draw back to a definite height, leaving the sulphide surface above quite dry. For gangue the water does not draw back quickly, but remains, wetting it for some time. The sulphides are proved interfacial in this way, and the measurements of the height of the point of contact above the general level are interesting. The measurements were made with a cathetometer.

Material	Water, mm.	0.1% H_2SO_4 mm.	0.1% NaOH, mm.
Chalcocite	1.55	2.10	3.07
Chalcopyrite	2.60	2.50	2.90
Gangue (silicate)	3.20	3.25	3.30

The figures for the gangue are not at the point of contact, for there is none, since it is thoroughly wet by water, but are at the point where the meniscus becomes parallel to the face of the mineral surface. The mineral giving the smallest rise should be the most interfacial and the best floating. This was found to be true, for, without oil, chalcocite is a better floating mineral than chalcopyrite, at least for the ores that were tested. The figures above also show that in alkaline solution a very poor float should be made, as the rise is almost as much as for the gangue. This was also found to be true. Differences even among sulphides are clearly shown, hence it is not surprising to find all gradations in floating-properties among ores. These measurements, made on large pieces of mineral, with ground and partly polished surfaces, may not correspond exactly to those for an ore-surface, though in the cases mentioned they were found to give results agreeing with practice.

Another point noticed in these measurements, which is an important one, is how quickly the water is displaced from a mineral-surface when brought in contact with air. If an air-bubble comes in contact with a sulphide particle immersed in water, it must partly displace the water from the sulphide rather quickly if it is to be floated in a pneumatic cell. This was tested for the same minerals, by noting the time taken for the solution to come back to the final point of contact, when the mineral was raised, with the following general results:

(1) Water and acid solutions are removed more quickly in air from chalcocite than from chalcopyrite.

(2) Little difference is noted between acid and neutral solutions.

(3) Alkaline solutions are removed very slowly from all sources.

(4) All solutions adhere strongly to gangue.

These facts also agree with the practical results mentioned above. The success of the Potter-Delprat process may well be due to these facts, since the CO_2 is generated in contact with the sulphide, and time is given for the solution to be partly displaced by the gas or, in other words, for the sulphide to attain the interfacial condition and be floated. When a soluble frothing agent is used, without oil, the same principles apply, the frothing agent simply modifying the water to a certain extent.

The use of oil introduces several new factors which make the problem more complex, but the same principles apply. The sulphides can now be interfacial between water and air as discussed above, but, in addition, may be interfacial between water and oil, or even go into the oil-layer. This oil-layer is on the bubble-surface and the forces holding the sulphides to this surface, if it has an oil-film, are much greater than when no oil is used. This point will be proved a little further on. The oil-layer on the bubble-surface need be only of minimum thickness to act, in contact with water, the same as a layer of oil on water, as far as interfacial tendencies are concerned. Let

$T_{s\ w}$ = interfacial tension sulphide-water,
$T_{s\ o}$ = interfacial tension sulphide-oil,
$T_{o\ w}$ = interfacial tension oil-water.

Then, if (1) $T_{s\ w} > T_{s\ o} + T_{o\ w}$, the sulphide will go into the oil-layer completely; (2) no one interfacial tension is greater than the sum of the other two, the sulphide will go to the oil-water interface, and the three phases will be in contact at a certain contact-angle. The gangue is thoroughly wetted by water, that is, $T_{g\ o} > T_{g\ w} + T_{o\ w}$.

These inequalities have been stated and applied to the flotation process by Ralston.[6] The second condition given above, where the sulphides are interfacial, seems to be by far the most general, though the first condition may be, and probably is, realized, especially when tarry oils are used, which, in grinding with the ore, coat the sulphides more or less with this tarry material. It is doubtful if the lighter oils or the lighter constituents of a tarry-oil mixture film the sulphide at all in grinding, but rather it is probable that this oil is emulsified in the operation. The condition where the mineral is completely filmed by oil would be the best floating condition, and this could be realized in the flotation cell, where this film would be continuous with the oil-film on the bubble-surface. All gradations of the interfacial conditions are possible, from those that show only a slight tendency to be wet by water in the presence of oil, to those that are thoroughly wet, which is the case of the gangue-material.

Experimental determinations of the interfacial tendencies of various minerals were carried out in the same way as described above, except that in this case the interface was oil-water, or aqueous solution. In Fig. 2 is represented the case of a sulphide surface at this interface. The floatable materials were all interfacial, and the sulphides showed a decided preference for the oil. This is an important point in showing that the same

[6] M. & S. P., Oct. 23, 1915.

sulphides are much more strongly held to an oil-covered air-bubble than to one not so covered. In Fig. 1 the sulphide, while interfacial, shows a preference for water over air, and would easily be displaced in actual flotation from the interface and go back into the water. In Fig. 2

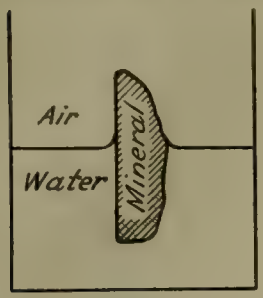


Fig. 1.

Fig. 2.

the meniscus is now pushed downward into the water, instead of upward, hence the sulphide is held much more strongly to oil than to air.

The following measurements were made after the meniscus had come to the true point of contact of the three phases, and this point was closely the same, whether the mineral was first wet with the oil or solution. The averages of these two figures are given. Kerosene, and a kerosene pine-oil mixture, were used mostly, as the interfaces are better defined, especially in acid and alkaline solution, than with many actual flotation oils. These other oils act in the same way, however.

DEPRESSION OF MENISCUS: KEROSENE AND CHALCOPYRITE

Water	0.1% H_2SO_4	1% H_2SO_4	10% H_2SO_4
2.99 mm.	2.02 mm.	1.32 mm.	0.75 mm.

Calcite in contact with neutral, acid, and alkaline solutions and kerosene showed interfacial tendencies in alkaline solution only. Malachite exhibited a small interfacial tendency, except in alkaline solution in which it was thoroughly wet by the solution.

KEROSENE AND PINE-OIL AND AQUEOUS SOLUTION

This was a flotation mixture of 90% kerosene and 10% pine-oil.

Solution	Depression of meniscus Chalcopyrite, mm.	Chalcocite, mm.
Water	3.10	3.42
0.1% NaOH	1.98	2.54
0.1% H_2SO_4	1.45	2.95

Gangue-material in all cases is thoroughly wet by the solution, especially if it is wet by the solution before coming in contact with the oil, as is the case in actual flotation. The case of chalcocite in water, given above, is almost a condition of complete wetting by oil. These experimental results in every way justify the theoretical discussion given, and also show that alkali and acid lower the interfacial tension sulphide-water as the preference for oil is not as great in these solutions as in water, although the sulphide is still distinctly interfacial and hence can be easily floated from acid or alkaline pulps. These results were obtained by the use of a clean sulphide-surface, but in actual flotation this may not be true for all the particles, and since the interfacial properties are a function of the surface only, one may expect many differences from these ideal measurements. In alkaline solution, for example, there may be some of the mineral which, like calcite, is more interfacial in this solution than in water, and hence would float, although it would not do so in a neutral pulp. In tests it has been found with some ores and oil-mixtures that in an alkaline pulp a better recovery was made in the usual length of time than by prolonged flotation in neutral pulp. This might be true also in an acid pulp for some minerals.

It has been noticed that some surfaces have a strong tendency to hold fast to the liquid, first wetting them and not to allow it to be easily displaced by another liquid. In the work upon interfacial tension, described above, such a surface would show a great difference in preferential action or angle of contact, dependent upon whether it was wet with oil or water first. It has also been observed that it is principally those substances having smooth or shiny surfaces which float, while those having dull or rough surfaces do not float. These observations and others point to the following explanation of the mechanism of this action: there is first the inherent property of each substance to adhere to oil or to water to a certain degree. When the substance is brought to the interface between water and oil, these forces tend to come to equilibrium with the third force, the interfacial tension between oil and water at some definite contact-angle. Here is where the physical nature of the solid surface comes into play. If the surface is smooth and shiny, such as that of a polished metal or a freshly fractured sulphide crystal, then the liquid first touching it is easily pushed back to the position of equilibrium. If, however, the substance has a dull, that is, a capillary surface, so that the liquid first wetting it is strongly held in its pores, then, when it is brought to the interface it may exhibit no interfacial properties at all, although, if it were smooth, it might even show a preference for the other liquid. This shows the reason for the difference, or hysteresis, of the contact-angle noted for some surfaces. It also explains why a particle having such a surface, if first wet with water, as is the case in flotation, will be very difficult to float, since it will not easily be brought into contact with oil.

The function of the bubble is to give a large surface to which the sulphide may go and be floated. As already stated, the air-bubble in oil-flotation is covered wholly or in part by an oil-film. For the action of oil on water, see Devaux[7] and Langmuir.[8]. It is not necessary that the oil completely cover the bubble, and it probably does not in the greater proportion of the bubbles. The supply of oil for the bubbles will be discussed under the action of emulsions. If an oil droplet be placed on water or aqueous solution, it will spread over the surface provided the surface-tension of the water is greater than the sum of the surface-tension of the oil plus the interfacial tension oil-water, that is, this inequality must be true:

[7] *Ann. Report Smithsonian Inst.*, 1913, 261.
[8] *Met. & Chem. Eng.*, 15 (1916), 469.

$$T_{w\ a} > T_{o\ a} + T_{o\ w}$$

For oil-flotation this must be true for all solutions used, as the air in the bubble, surrounded by the pulp, presents this same condition. If to water be added some material which lowers its surface-tension ($T_{w\ a}$), without lowering $T_{w\ a} + T_{o\ a}$ to an equal amount, the inequality is reduced, and finally a point is reached where the oil will not spread on the solution. This is easily realized in the case of soap-solutions, and with many other substances that lower the surface-tension greatly. In this condition a poor float would result. In flotation, in order to produce a froth, material such as the soluble portion of pine-oil is added which lowers the surface-tension of water. Unless this helps in other ways than in producing a froth, it should be used in as small a quantity as possible, and this agrees with many practical observations. The frothing agent added also lowers the interfacial tension oil-water, but here it must be remembered that even if the interfacial tension be lowered in the same proportion as the surface-tension, the inequality is less than before, since the interfacial tension is much smaller than the surface-tension of water. The other factor, the surface-tension of oil ($T_{o\ a}$), is not changed much, for inorganic salts do not dissolve in it. If, however, some substance be added which will not lower the surface-tension of water but will lower the interfacial tension oil-water, then this should produce better oiling of the bubble. This can be done with alkalies and in the case of some oils by acids.

An important point in connection with the use of the pneumatic cell is the time during which the bubble is in contact with the pulp as it passes through, as here it must be attached to the sulphide particles. Any reagent that will give a quicker filming of the bubble-surface by oil, after it comes through the blanket, will be of benefit in the rapidity with which the mineral is attached and raised. Alkalies, as explained, produce a greater inequality between $T_{w\ a}$ and $T_{w\ o} + T_{o\ a}$, and hence the oil will be spread out quicker over the surface than without their use. A large number of surface and interfacial tension measurements were made, a few of which are as follows:

Surface Tensions

	Dynes per cm.
Water 25°C.	71.8
Kerosene	25.2
Coke-oven oil	28.0
Pine oil	30.0
0.01% solution terpineol	68.6
0.1% solution terpineol	49.2

Interfacial Tensions

Kerosene-water	32.8
Kerosene and pine oil-water	11.6
Kerosene and pine oil-0.05% solution NaOH	7.3
Kerosene and pine oil-0.2% solution NaOH	4.5
Kerosene and pine oil-0.2% solution H_2SO_4	13.2
Coke-oven oil-water	14.1
Coke-oven oil-0.05% solution NaOH	5.8
Coke-oven oil-0.2% solution NaOH	2.6
Coke-oven oil-0.1% solution Na_2CO_3	6.6
Coke-oven oil-0.2% solution Na_2CO_3	4.4
Coke-oven oil-0.2% solution $Na_2B_4O_7$.10 Aq	8.0
Coke-oven oil-0.1% solution $Na_4P_2O_7$.10 Aq	9.6
Coke-oven oil-0.2% solution $Na_4P_2O_7$.10 Aq	7.4
Coke-oven oil-0.4% solution H_2SO_4	14.4
Coke-oven oil-0.01% solution saponine	9.3
Coke-oven oil-0.01% solution tannic acid	12.7
Coke-oven oil-0.01% solution hemoglobin	8.9

Considerable data of this kind are given by Lewis[9] and Shorter and Ellingsworth[10] on the action of dyes, salts, and soap. The drop number apparatus used was the same as described by Shorter and Ellingsworth. Their work also shows that soap and alkali together are extremely active in lowering the interfacial tension oil-water. This would be the condition in an alkaline pulp, as there would then be free alkali and some saponified material with many of the oils used.

The results when colloidal material is present are subject to great variation, due to different speed of formation of drops. The figures given above for these materials approach the dynamic value, as the rate of dropping was fairly rapid. The static values are much smaller, and are interesting in connection with the emulsifying power of these substances. As an example of this the following result on coke-oven oil against 0.005% hemoglobin solution is given. The time is for the total number of drops formed.

Time	Drop No.	Interfacial tension, dynes per cm.
2 min. 40 sec	22.5	13.2
1 hr. 4 min	84.0	3.5

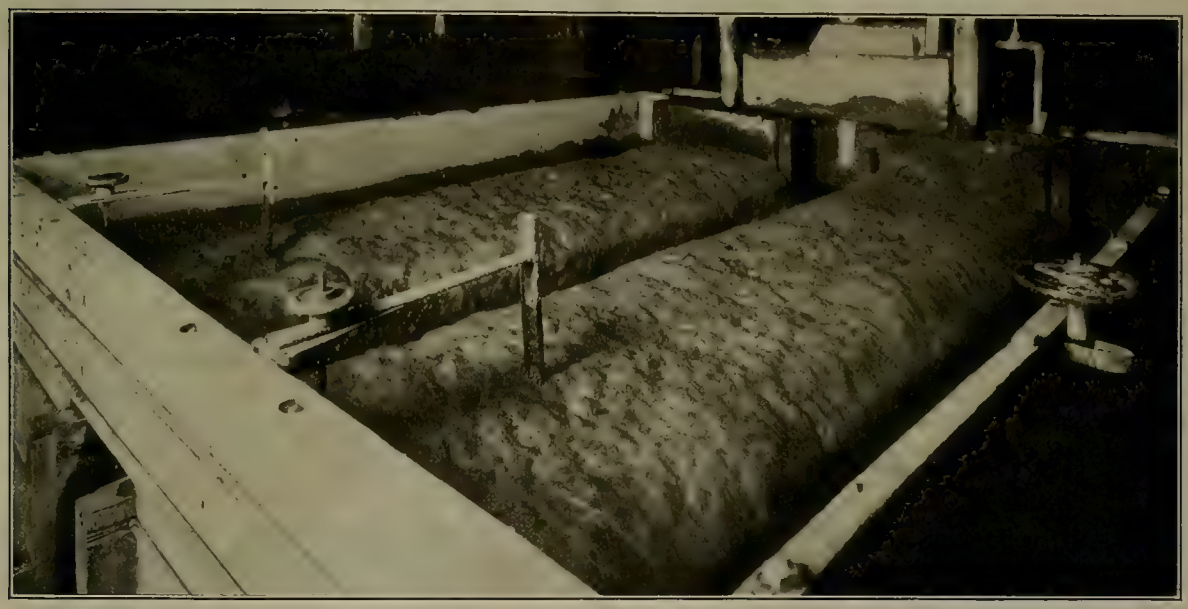
It is seen from the table above, that besides NaOH itself, any salt that hydrolyzes to give an alkaline solution lowers the interfacial tension, and all these salts are beneficial to flotation.

The behavior of the oil at the bubble and sulphide surfaces has been given. In the pneumatic cell this oil is supplied by an emulsion or a coarser suspension of oil in water. In the agitator-type machine, the oil may be beaten in at the cell, though it is also customary to grind the oil with the ore. In either case the problem of emulsions comes in. In the pneumatic process this emulsion is formed in the grinding and must be good enough to last throughout the float, yet not so good as to fail to break down with sufficient rapidity to give free oil for the bubble-surface. The subdivision of the oil is such that no doubt almost all degrees of dispersion exist; the larger droplets may be of sufficient size for one to coat a fair area of a bubble-surface, but the better emulsified portion is of such size that many particles have to unite to give oil enough for the minimum thickness of an oil-film, to spread over even a square centimetre. This can be calculated from the minimum thickness of an oil film[11] and the size of the particles in an ordinary oil-emulsion.[12]

Experimental evidence on these points is conclusive. If a coarse suspension of oil be made simply by shaking

[9] *Zeit. phys. Chem.*, 74 (1910), 619.
[10] *Proc. Roy. Soc.*, 92 (1916), 231.
[11] Devaux, *Loc. cit.*
[12] Ellis, *Zeit. phys. Chem.*, 80 (1912), 597.

the ore, oil, and water together in a bottle by hand, and then put in a small Callow cell, only a partial float results, and the operation must be repeated several times, adding more oil each time, in order to get a good recovery. If, however, too good an emulsion is had, a poor recovery results. For this purpose a kerosene pine-oil mixture was emulsified with water in a De Laval emulser and allowed to stand over night, and a middle portion of this emulsion was removed for the tests. This emulsion added at the cell gave a small float at first and then stopped. On adding a little acid no further float resulted, but, by allowing the pulp to stand for a few minutes, an additional amount of sulphide was raised, and finally a good recovery was made, though considerable time had to be given for the emulsion to give up its oil. This was also found to be true for another oil that gave an excellent emulsion on simply adding it to water.



TYPICAL FROTH FORMED IN A CALLOW CELL

It is interesting to note that in these cases it was proved that it was not necessary to grind the oil with the ore, but, by adding it as an emulsion prepared by itself, as good a recovery results. This probably is not true for oils containing tarry matter as explained above. It was also noticed in using the second emulsion, named above, that flocculation of the slime took place in neutral solution, and that these then floated to a large extent, giving a non-preferential float; when, on the other hand, the emulsion was broken by acid and alum, a good preferential float resulted. It was found that this slime in neutral pulp had flocculated with the oil-emulsion so that, on standing, all the oil was carried down, though the emulsion was not appreciably broken.

The value of acid and salts having a polyvalent cation has been demonstrated in some cases, usually in connection with the Minerals Separation type process. In this process there is greater danger of getting too good an emulsion than in the Callow process, and the value of acids and salts of this type consists in their power of breaking down an emulsion, or preventing too good a one being formed. These salts should be used in acid solution, or, otherwise, due to hydrolysis, the insoluble hydroxides formed, for example, $Fe(OH)_3$, and $Al(OH)_3$ have the opposite effect, namely, of preventing the breaking down of the emulsion or promoting its formation.[13] Oil-emulsions in $FeCl_3$ solution, on standing, give a yellow flocculent precipitate, but the emulsion is not broken. The mechanism of this is discussed by Ellis.[14] In a neutral, pneumatic, Callow float, such salts have been found to be harmful. If salts of iron or aluminum are present in the feed-water then acid may be necessary to prevent this action between them and the oil-emulsions.

The value af alkalies has been discussed as giving a better oiling of the bubble-surface. In connection with emulsions, however, a greater effect can be ascribed to the action of alkalies or salts which hydrolize to give an alkaline reaction, and to those which have a polyvalent anion. If a neutral ore-pulp is shaken with a small quantity of an oil-emulsion it is found that the slime is coagulated with the emulsion and settles out, often leaving the liquid quite free from oil-emulsion. The emulsion is not broken, but simply carried down with the flocculated slime. If alkalies are used, or salts such as last mentioned, then the slime is deflocculated in the great majority of cases. It then settles more slowly, and when it has settled the emulsion is left free and still standing. This is important, for now the emulsion is free to function as it should, that is, to give oil to the bubble-surface. The ore-particles, both sulphide and gangue, are also free to show their own behavior toward

[13] Briggs and Schmidt, *Jour. Phys. Chem.*, 19 (1915), 478.

[14] *Zeit. phys. Chem.*, 89 (1914), 149.

the water and the oil. This deflocculation should, and does, result in a higher grade concentrate and a greater and quicker recovery, since now no sulphide-particles are coagulated with, or surrounded by, gangue-particles that prevent their flotation.

The use of lime has not been found to be as beneficial as that of NaOH. This is explained by the fact that this substance due to the predominating effect of the calcium ion, coagulates instead of deflocculating the slime, and hence part of the emulsion is removed and the individual particles are not free to float as they should. This coagulating action may be more noticeable in a Callow cell than in a cell of the Minerals Separation type, as in the latter the coagulated slime may be broken up considerably, but the tendency is the same in either case.

The principles involved when varying quantities of oil are used, is a question on which there is great difference of opinion. From theory there should be no difference whether a large or small amount of oil be used, provided the oil is properly emulsified. If a large amount, 2% or 3%, be used, and is not emulsified sufficiently, the excess may float and be of disadvantage in several ways. To test this point a float was made with an amount of oil equivalent to 2% of the weight of the ore, emulsified in a De Laval emulser, and added at the cell (Callow), and a float made. It behaved in every way the same as when 0.2% or less of oil was used, and the recovery was better, with as high a grade of concentrate. Of course, economy would settle the minimum amount of oil to use. This was repeated with other oils and ores. The extra amount of oil used gave a greater oiling of the bubble-surface, and in fact these floats were better than when alkali was used to make the smaller amount of oil more efficient.

In the light of the above work the question of flotation 'poisons' was taken up with the idea that any substance which will prevent the breaking down of an emulsion or coalescence of oil droplets, or which gives adsorption of colloidal particles at the oil-water interface, is harmful to flotation. In the first two cases the proper amount of oil will not be freed, and in the other case the oil-surface, if formed, would be covered by an adsorbed layer, so that no oil-surface would be presented for attachment of the mineral. Experimental work, by actual flotation, had shown what substances, including many dyes, were harmful. Solutions of these substances of 0.01% strength were shaken in test tubes, with about 2 c.c. of oil, for a few minutes, to the same extent and at the same time. The tubes were then placed upright and the amount of emulsification and the rapidity of coalescence of the oil droplets rising to the top noted, with the following results:

(1) Slight or no emulsification and rapid coalescence of droplets when using methylene blue, saffranine and bismarck-brown. These dull dyes really act like salts, and are not colloidal, nor are they harmful to flotation. In fact, these dyes assist slightly in breaking an emulsion.

(2) Extremely slow coalescence of droplets, the finely divided oil layer lasting for several hours to days, when using congo-red, bengoazurin, azo-blue, saponine, tannic acid, waste sulphate liquor, hemoglobin, and eosin. These substances are all injurious to flotation. Most of these are negative colloids. Hemoglobin is highly colloidal, and positive, and its adsorption is probably enhanced because it is oppositely charged to the oil-emulsion. Several of this last class of substances, especially saponine, gave marked emulsification, even with the small amount of shaking received. Some of these substances also form quite stable and viscous skins at oil-surfaces. Another experiment consisted in dividing an oil-emulsion into two parts, to one of which tannic acid was added, and then frothing over equal volumes of each in a small cell. The one to which tannic acid had been added contained 3.5 times as much oil in the residue or tail-water as the other. This shows that the oil-emulsion had been kept from breaking down, and the oil being frothed over. Besides the substances given above, the injurious effect of insoluble hydroxides of the heavy metals has been explained under emulsions. Other inorganic colloids have been found to be injurious, for example, when floating with $K_4Fe(CN)_6$, the $Cu_2Fe(CN)_6$ formed from the oxidized and soluble copper hurts the float very noticeably. The experimental evidence proves that the action of these colloids is, without doubt, as stated, though they may also adsorb at the solid surfaces, and in that way cause a poorer result to be obtained. It is easily seen how the water used in flotation and the slime coming from certain ores, have a great effect in flotation. This has caused some to say that it is the gangue that determines the success of the process, and if the water-supply be included in this, they are to a certain extent correct.

The froths produced in flotation are useful as a mechanical means of removing the mineral brought up by the bubble. The formation of a froth, and its stability, are due principally to dissolved materials in the water which give to the solution a variable surface-tension. The static surface of a solution has a lower tension than a fresh surface, whether the substance added lowers or raises the surface-tension of the solvent. Since a large lowering may be caused by a small amount of solute and only a small rise may be obtained, the best frothing agents are those that lower the surface-tension. Pine-oil is used to a large extent for this purpose in practice, the soluble portion causing a considerable lowering of the surface-tension of water. In many articles that have appeared on the theory of flotation, it has been stated that oils lower the surface-tension of water. This is not very clearly stated, since, as ordinarily understood, oil is insoluble in water, and only soluble material can affect the surface-tension of water. Besides the soluble portion of pine-oil, a part of many other flotation oil-mixtures is soluble and gives a froth. Terpineol, menthol, and many such substances are powerful frothing agents. The lasting qualities of a froth, as stated above, are due to its variable surface-tension, for if a bubble starts to thin out or to break at a certain point this fresh surface has a greater surface-tension than before, hence

is automatically strengthened at this point and resists rupture. In using alkalies it is observed that a more quickly breaking froth results in a pneumatic cell. This can be explained by the fact, as stated before, that a greater extent of bubble-surface is covered with oil, hence there is less surface which contains only the adsorbed frothing agent, and since oils themselves do not produce good froths, the froth breaks more quickly than when alkalies are not used; or, this observation may be used to support the view that the bubbles are better oiled in an alkaline pulp. A froth is also stabilized by the slime present in a pulp, or by other colloidal matter. Colloidal material dissolved in the oils will make an oil-froth more lasting. A mixture of oils, the same as an aqueous solution, gives a better froth than a pure oil.

Considerable weight has been placed by many upon the electrostatic forces that might be present in the flotation process. Some have even considered the attraction that holds the sulphide to the bubble-surface to be of this origin. Air bubbled through water has been found to carry ions,[15] and from this, and the fact that most substances have a contact-difference of potential when in contact with water or solutions, an electrical theory has been built up, though in many cases serious errors have been made regarding the action of these forces. Measurements were made to determine these forces. The small metal Callow cell used was grounded, as this condition prevails in actual practice. The charge carried by the air issuing from the flotation pulp was discharged on a metal screen placed above the cell, and the effect measured by means of a Dolezalek electrometer. The readings in this case are measured in volts per minute. The charge upon the air from several pulps was measured and in no case did it exceed 0.011 v. per minute, and was usually only about half that value. The air was negative in neutral pulps, but slightly positive in one of the alkaline pulps. The charge on the froth was also measured, and this varied from zero to 0.011 v. as the maximum. This was sometimes positive, and under other conditions negative. In two good floating pulps the froth was at almost zero potential, though 0.002 v. could easily be determined. It seems, then, that these electrostatic effects are far too small to exert any important part in flotation, and cannot possibly be the force that holds the sulphide to the bubble. This, too, would require a dielectric film, such as oil, between the two oppositely charged bodies, the sulphide and the gaseous ions in the bubble; but since flotation results without the use of oil in many cases, and, without doubt, the bubble-surfaces are often not completely covered by oil even when oil is used, it seems that this theory cannot hold. The contact difference of potential of various minerals has been used in some theories. These were also measured by an electro-endosmose method as described by Perrin.[16] To this apparatus a small calibrated tube was sealed at the top of the diaphragm side, so that when dilute electrolytes are used the gas generated can be forced over into this tube, after the experiment is over, and this correction applied to the amount of liquid apparently transferred through the powdered material. The distance between the electrodes was 12 cm. and the potential 110 v. The results obtained give the sign of the charge on the solid in contact with the water or solution, but quantitative results as to the actual potential differences are difficult to obtain in this way. However, some idea can be had by comparing the amount of liquid transferred for the minerals, to that transferred in the case of silica, whose potential difference against water has been found by cataphoresis measurements. This is found to be approximately -0.042 v. For quartz and ferric hydroxide, see Whitney and Blake.[17] The results obtained are as follows:

Mineral	Liquid	Sign of solid	Liquid transferred, cu. mm. per min.
Silica	Water	Negative	30.7
Alumina	*N*/100 HCl	Positive	40.0
Chalcopyrite	Water	?	Approx. 0
Galena	Water	Negative	3.6
Sphalerite	Water	Negative	6.1
Molybdenite	Water	Negative	3.7
Malachite	Water	Positive	4.0
Malachite	*N*/500 HCl	Positive	17.8
Galena	F. W./500 $FeCl_3$	Positive	44.3

Here the sulphides tested are seen to be slightly negative against water, or practically zero in the case of chalcopyrite. This agrees with our ideas concerning the contact-difference of potential of these substances and with cataphoresis experiments on colloidal sulphides, and the like. Malachite is positive, as would be expected from its basic character. The last result given in the table is probably due to the formation, by hydrolysis, of ferric hydroxide, and its adsorption on the surface of the mineral, so that the action is exactly the same as for ferric hydroxide itself. In this case again, no attraction can exist on the basis of electrical charges between sulphides and oil in emulsions, since they are of the same sign. The charges on oil in emulsions in dilute salt-solutions, etc., are given by Ellis,[18] Powis,[19] and others. This, however, would not determine the charges on a mineral and oil, if the two were in actual contact, as is necessary for flotation. The charges carried by the oil in emulsions are important probably in connection with positively charged colloids which act as poisons, and, of course, the coagulation of slime, and the breaking of an emulsion by electrolytes, is a function of the charge carried by them; but it is not possible to use these charges as an explanation of the primary principles involved in flotation.

The following is a summary of the conclusions arrived at as a result of the experiments made:

(1) For an ore particle to float, it must be interfacial between oil and water, or it must go completely into the oil-phase. If no oil be used, the particle must be inter-

[15] Lord Kelvin, McLean and Galt, Proc. Roy. Soc., 1894, 57; Coehn and Mozer, *Ann. Physik*, 43 (1914), 1048.

[16] *Jour. chem. phys.*, 2 (1904), 601.

[17] *Jour. Am. Chem. Soc.*, 26 (1904), 1339.

[18] *Zeit. phys. Chem.*, 78 (1911), 325.

[19] *Ibid.*, 89 (1914), 91.

facial between water and air. The force holding the particle to the bubble is much greater when oil is used.

(2) In addition to its value as a lifting agent, the bubble serves to produce a large air-surface in contact with the pulp. This surface is covered to a greater or less extent by an oil-film, to which the mineral may go, so that a small amount of oil is very efficient.

(3) The oil should not be so well emulsified that it will not be given up to the bubble-surface; and yet should be sufficiently emulsified, in a pneumatic process, to last during the time of floating.

(4) Colloids in general are harmful, owing either to their causing too stable an emulsion, or to their adsorption on the oil-film at the bubble-surface, preventing mineral attachment. This is the action of the so-called 'flotation poisons.'

(5) The froth formed is attributable either to the soluble portion of the flotation mixture, which produces a variable surface-tension, or to finely divided or colloidal materials.

(6) Acids, alkalies, and salts affect all these factors.

(7) The electrical effects, other than the colloidal charges, are not important in flotation.

(8) The nature of the solid-surface, in relation to its wetting properties, has been discussed and an explanation of the 'hysteresis' of the contact-angle advanced.

In the light of present knowledge it is impossible to measure many of the forces operative in flotation, such, for example, as the interfacial tensions between solids and liquids, or to explain the mechanism of adhesion. Such problems are, however, nearer solution, due to the material advances made recently by Laue[20], and by Bragg and Bragg,[21] by which the actual arrangement of the atoms in a crystal may be determined, and also by Langmuir,[22] whose work on the constitution of solids and liquids, the structure of solid-surfaces, and the mechanism of adsorption, leads toward the solution of this problem. While the flotation of each ore still remains more or less of a problem in itself, yet a clear understanding, and the proper application, of the principles involved will lead to an earlier solution of the problem.

COPIAPITE is a mineral of sulphur-yellow color, often with a shiny lustre, and superficially suggesting gold when occurring in masses. It is a basic sulphate of iron, $2Fe_2O_3.5SO_3.18H_2O$. It is a product of oxidation of pyrite under special conditions that are most often found in desert climates. It is seen at times accompanying copper ores where copper and iron vitriols are simultaneously formed; it is frequently formed in pegmatitic quartz dikes that had contained sulphides; it is also produced in the alteration of wolframite from the oxidation of the pyrite that is generally present in microscopic particles disseminated through the crystals; and it often occurs in thin films through rhyolite dikes from the oxidation of minute quantities of pyrite in the rock.

[20] *Sitz. Akad. Wiss.*, Wien, June 1912.

[21] *Proc. Camb. Phil. Soc.*, 17 (1912), 43; and treatise on 'X-Rays and Crystal Structure.'

[22] *Jour. Am. Chem. Soc.*, 38 (1916), 2221.

Perseverance Mine Powder-Thawer

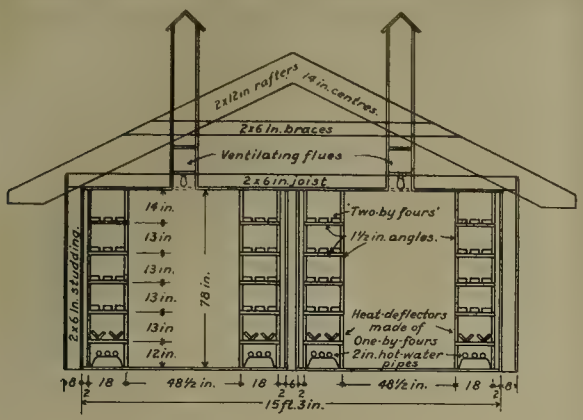
By D. J. ARGALL

The powder-house of the Perseverance mine, near Juneau, Alaska, is situated 500 ft. north from the collar of the shaft, or 5-level station, at an elevation of 2300 ft. It is connected with the 5-level station by a covered tramway, or snow-shed. In the snow-shed, 42 feet from the powder-house, is a cement archway 20 ft. long, with a steel door in the middle, to serve as a fire-break. The building is 40 ft. long, 15 ft. 3 in. wide, and is constructed of lumber. It is finished inside with tar-paper on the studding and $\frac{7}{8}$-in. ship-lap; outside is double ship-lap with tar-paper between. The roof is made of double ship-lap with maltoid covering. On this covering are 2 by 12-in. planks, and on top of these 2 ft. of loose earth. Earth is also banked around the sides and ends of the building, which is strongly constructed to carry an excessive snow-load. Last winter there were 10 to 15 ft. of snow on the roof. The extra heavy construction caused additional cost. The inside is divided by a partition, making two separate compartments. A car-track extends through the middle of each compartment. There are two 16-lb. rails, 18 in. apart, extending from floor to ceiling, and spaced 7 ft. centres, braced with $\frac{1}{2}$-in. angle-iron. The angle-irons also support four rows of shelving placed around the sides of each compartment. The shelves are spaced 13 in. apart and are 18 in. wide. Each shelf is constructed of three 2 by 4-in. removable boards. Each compartment has a capacity for 320 fifty-pound boxes of powder.

Ventilation is provided in each compartment by 8 air-shafts, 8 by 12 in., through the ceiling, connecting with 12 by 12-in. air-ducts outside. In front of each air-shaft is a slide-gate to regulate ventilation. The powder comes into the mine weekly from Thane, in 8-ton lots, is hoisted through the shaft, and trammed to the powder-thawer, and the boxes are placed on the shelves. The powder is thawed in the boxes without any unnecessary handling. This makes the thawing cheaper and less dangerous. After the powder has been in the thawer 48 hr. it is ready to be distributed throughout the mine as required. The usual method is to use each compartment alternately.

The hot-water heating arrangement is as follows: each compartment has 2115 cu. ft. of space, and is heated by two complete units consisting of a coil, and two 110-v. 4800-watt Bayonet heaters, with one thermostat in each compartment. The coils are placed 4 in. above the floor, under the shelving with heat deflectors. The Bayonet heaters are installed in a concrete station 5 ft. 6 in. wide, 8 ft. 6 in. long, and 9 ft. high, with a steel door, 22 ft. distant from the thawer. There also are installed the automatic controller, expansion tank, four 3-point heat-controlling switches, and a main line switch. One coil in each compartment is in constant operation. This coil is used to govern the heat, and is connected with the thermostat in the compartment. Each Bayonet heater has three points of regulation, namely, low, medium, and

high. These heat-regulations are controlled by the four 3-way switches. By throwing in all the heat at one time a maximum temperature of 118° F. can be obtained, thus affording ample protection in case of extremely cold weather. It is, of course, understood that this temperature can be obtained only by throwing out the heat-con-



VERTICAL TRANSVERSE SECTION OF POWDER-THAWER

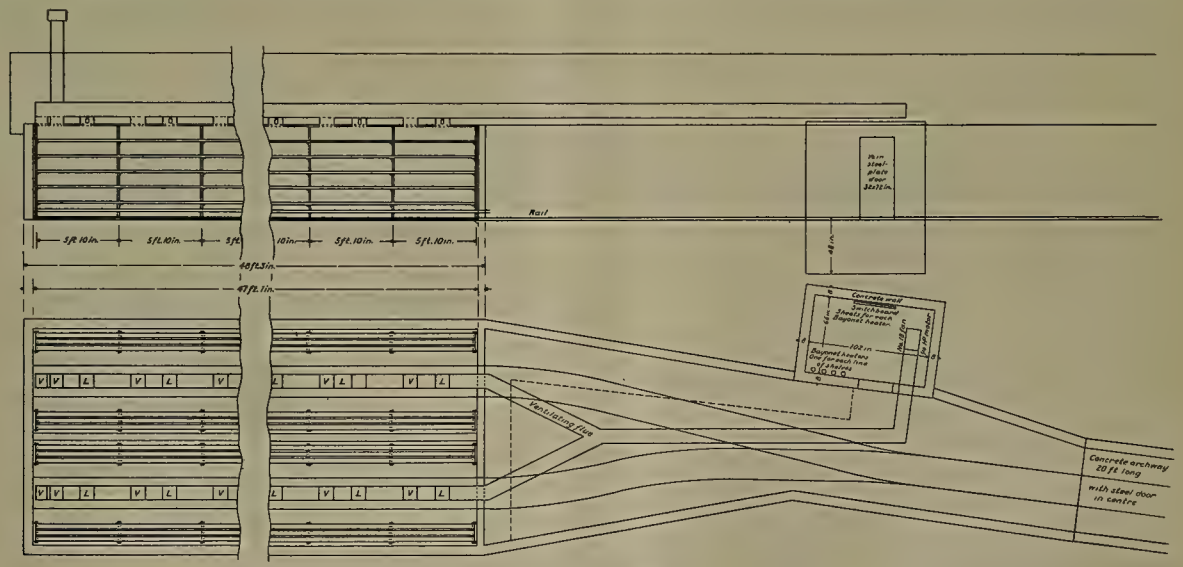
trolling device, as the thermostats are set to allow only a maximum of 90° F. Under ordinary conditions, setting the 3-way switches at the low position, has been found to take care of the requirements. The heat-controlling device consists of an aluminum expansion-band connected to a brass strip, at the end of which are platinum contact-points which make a break-contact with a solenoid, which in turn is connected to the necessary levers which control the switch operating the Bayonet heater. The solenoid is wound for operating on a 110-v. alternating current. The expansion-tank has a capacity of 5 gal., which is more than ample, as the evaporation is practically negligible. A gauge-glass is installed on the tank for protection.

The hot-water piping is arranged in four sections with 36 gal. of water in each section. There are 200 ft. of 2-in. pipe in each section. The air circulation in the thawer is accelerated by a 1¼-hp. motor, 110-v., direct connected to a suction fan, which pulls air from a 7½-kw., 110-v. electric heating device, intermittent duty, and discharges uniformly to the thawer compartments.

Further details of the construction and its equipment appear in the table below:

Shelf capacity, tons	16
Number of compartments	2
Cubic feet per compartment	2295
Watts per compartment	625
Watts per cubic foot	0.273
110-volt Bayonet heaters per compartment	2
Size of Bayonet heaters, watts each	4800
Number of coils per compartment	2
Two-inch pipe per coil, square feet	200
Radiating surface per coil, square feet	184
Amount of water per coil, gallons	36.8
Watts required per gallon of water	8.76
Capacity of expansion-tank, gallons	5

All wiring for lighting is enclosed in a double galvanized-iron conduit. All outlet fittings are of the latest water and fire-proof marine type, making an ideal fire-proof installation. The powder-thawer is easily accessible from all parts of the mine. It is remote from other buildings, and the cost of heating is very low. When the current consumption was taken the outside temperature ranged from a maximum of 10° to a minimum of 6° F. The inside temperature ranged from a maximum of 82° to a minimum of 76° F. The two 4800-w. Westinghouse Bayonet hot-water heaters required 30 kw.-hr. per 24 hours.



PLAN OF POWDER-THAWER AT PERSEVERANCE MINE

The construction costs were: labor $2224.69; material and installation $3588.22; total $5812.91, representing a small capital expenditure for the capacity of the thawer.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

JUNEAU, ALASKA

THE READY BULLION MILL WORKING AT CAPACITY.—A NEW ENTERPRISE ON CHICHAGOFF ISLAND.—BIG GLORY HOLES BEING OPENED IN THE ALASKA JUNEAU MINE.

Since the flooding and the consequent shutting down of the Treadwell mines, things have been quiet on Douglas island. The Ready Bullion mine, the only one of the group still in operation, is keeping the Ready Bullion mill running to capacity. The cyanide plant is operating at present with one shift only, cleaning up the 240, 300, and 700 mills, as well as working the Ready Bullion concentrate.

All the machinery in the plants that have been shut-down is being salvaged and stored in warehouses until such time as it is needed, or is disposed of. No great change is apparent in the caved area, only small sloughs from the already shattered ground taking place continually. No word has as yet been given out officially as to the estimated value of the damage done by the caving and flooding of the mines.

Douglas City merchants have organized with a view to making up in some measure for the loss occasioned by the Treadwell shut-down, and to that end are making preparations to attract the business of the halibut fishermen.

Four sections of the Alaska Juneau mill have been placed in operation, this being one-third of the entire mill. No figures as to tonnage, or value of rock milled, are available as yet.

The inhabitants of Silver Bow basin are hearing the beat of machine-drills in the Alaska Juneau open-pits for the first time since the season of 1910. Four pits are being opened with a view to supplying the mill with an aggregate of 2000 tons per day.

The Hirst Chichagoff Mining Co. has taken a lease on the Hirst and Bahrt properties on Chichagoff island. The properties lie about 2000 ft. east of the Chichagoff mine, on the lode parallel to that of the latter. T. W. Shaffer, of Sitka, is superintendent of the property and expects to open up and equip the property to treat 50 tons per day by the end of this season. The company has a 15-year lease on the ground.

The $20,000 gold brick recently stolen from the Chichagoff mine, has been found in the woods near the mine. Two suspects are awaiting trial in the Federal jail in Juneau.

MAYER, ARIZONA

EXTENSIVE DEVELOPMENT OF AN IMPORTANT OLD BUT NEGLECTED DISTRICT.—OLD MINES AND NEW ARE NUMEROUS.—NEW METALLURGICAL PLANTS AND A RAILROAD PROPOSED.

One of the least advertised, and yet one of the most promising mining districts of the State is in the vicinity of Mayer, in Yavapai county. It lies 16 miles south of the big mines at Jerome. The formation is similar to that at Jerome, the character of the ore is the same, and in one mine at least, a grade of copper ore is being developed which will rival the United Verde mine. Mayer is one of the old camps of Arizona. It is named after the late Joe Mayer, who settled on Big Bug creek in the early days of the Territory. The estate owns the Mayer townsite, which has become valuable due to the recent development of the surrounding mining district. It is understood that a deal is now pending with Eastern people for the purchase of the townsite. The Mayer estate also owns several mining properties near the town, which is on the Prescott & Eastern railroad and in the centre of a rich mining region 20 miles square. A bank has recently been established here and a hospital is soon to be built.

There are from 20 to 25 producing mines in the Mayer district, each of which has a daily capacity of from 5 to 350 tons. The Blue Bell and the De Soto mines, owned and operated by the Consolidated Arizona Smelting Co., lead in the production. These are old properties that have been in course of development for some time. The Blue Bell outputs 350 tons per day, principally from the 800, 900, and 1000-ft. levels. The ore is chalcopyrite and pyrite which is broken from three separate ore-shoots ranging from 11 to 40 ft. wide. The shaft is to be sunk to 1100 and possibly to 1200 ft., at which levels drifts will be run to determine the extent of the orebodies.

The mine has over 5500 ft. of development and about 400,000 tons of ore developed. The De Soto mines is three miles south of the Blue Bell. It has 2000 ft. of development and an ore reserve of more than 100,000 tons. It is producing 150 tons per day. The ore from these two mines is shipped to the company's plants at Humboldt, where the high-grade is smelted and the low-grade treated by the flotation-process.

In a report to the company the general manager, G. M. Colvocoresses, stated that an increased saving of 20% has been obtained in the flotation-mill. The cost per ton is a little above $1. The president of the company, Charles A. Kittle, states that in a little over two years the company has been able to pay off $290,000 of floating indebtedness; has spent $500,000 on improvements and extensions to the plant; has accumulated a working-capital of more than $500,000; has changed a deficit of $295,000 to a surplus of $565,000; has paid $44,250 interest on the company's outstanding bonds for the year 1916; has increased the ore reserves from 150,000 tons to over 600,000 tons, and has increased the production of copper from 500,000 to 1,750,000 lb. per month.

Next to the Consolidated Arizona in tonnage is the Big Ledge company which owns the Henrietta, Butternut, and Sterling mines, four miles north-west of Mayer. These are also old properties from which considerable ore has been shipped. The present owners have been pursuing a thorough system of development. The ore is sent to the Great Western smelter at Mayer, which is owned by a subsidiary company to the Big Ledge company. The smelter is being operated with one furnace of 150 tons capacity, which is being increased by the addition of a second smelter of 500 tons capacity. This will be ready to blow-in about July 1. The third smelting unit of 400 tons is already on the ground and will be set up as quickly as possible, which will bring the total capacity up to 1000 tons per day. The company is building a large power-plant at the rear of the smelter.

A company that has come to the front recently with several surprises is the Arizona-Binghampton Copper Co., which owns the Binghampton mine formerly owned by the Stoddard Mines Co. just north of Copper mountain. Practically all of the stock of this company is owned by W. H. Reynolds, of New York. A block of the stock was recently floated, largely in Arizona, at par. The mine is developed to the 600-ft. level with numerous drifts and cross-cuts, the most of which are in shipping-ore. The most recent work has developed high-grade ore. For a distance of 100 ft. a drift has been run on a 12-ft. vein that averages better than 20% copper. It is chalcopyrite with

streaks of copper-glance. This mine has had shipping ore from the grass-roots. The company has a flotation-mill at the mine with a capacity of 125 tons daily, which is being increased to 250 tons. The property earned a net profit of $65,000 for the months of February and March, which was obtained principally from the lower grade ore that went through the flotation-mill. There is a joint agreement between this company and the Copper Queen company, which owns an adjoining mine, in the use of the mill. The Copper Queen company has the use of part of this mill without charge for one year. The Copper Queen company is controlled by people residing at Paris, Texas. It is a thoroughly developed property with sufficient ore reserves for a larger mill which is to be provided.

There is a long list of mines that are either producing a few tons daily or are making preparations to enter the shipping-list. Some of the best ones are: the Loma Prieta, Union, Bradshaw, Yaeger, Big Bug, Big Reef, Arizona National, War Eagle, Montezuma, United Arizona, Midnight Test, Wildflower, Little Jesse, Gold King, Iowa Copper, Hackberry, McCabe, Big Jim, Moscow, Minor, Stoddard, and Copper Mountain. These are scattered about within a radius of 12 miles of Mayer, and comprise only a small part of the producers of the district. It is known that at least six of the properties mentioned are being examined, with a view to purchase, by well-known engineers.

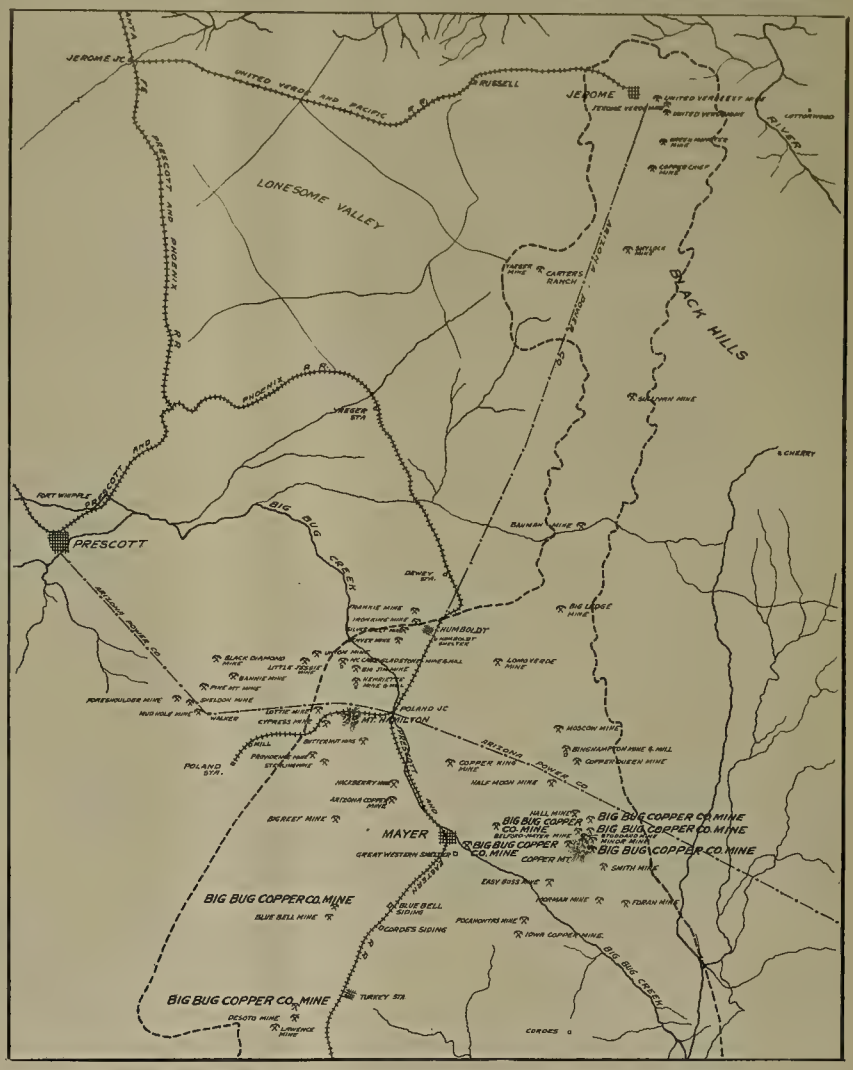
The Midnight Test mine is an old property, which, like many of the others, has been mismanaged and poorly developed underground. It is now owned by R. M. Merrill and Edward C. McManus, who are putting in their own money. Thus far about $25,000 has been expended in cleaning out old workings, re-timbering the main shaft, and in new work. These men have found the lost orebodies, which were not worked out but lost by the former owners. One vein in particular has been driven on 280 ft. above the 400-ft. level, which has opened a surprise in high-grade ore. A 60-ton Nissen mill, built by former owners, is to be equipped with the flotation-process.

The Loma Prieta company has demonstrated what good mining methods will do in finding ore. This is another old and abused property. Under the new management, a shaft has been sunk 400 ft. with frequent drifts and cross-cuts showing ore in every new place. A small shipment of the ore was recently made to the testing-plant at Wickenburg with a showing of 8.6% copper and some gold.

The Union is another promising property in which recent work has developed something like 100,000 tons of ore that will average $20 per ton in gold, silver, and lead. About 3000 tons of high-grade ore will run better than $500 per ton.

Another very promising property is that of the Big Bug Copper Co., which owns six separate properties, two adjoining the Blue Bell and De Soto, two near the smelter at Mayer, and two on Copper mountain, across the gulch from the Arizona-Binghampton. The company has commenced systematically to develop the several properties beginning on the Copper mountain mines. An excellent grade of copper ore outcrops in a net-work of veins on one of these claims, just as was found in the old Stoddard mine which is an adjoining property on Copper mountain. The Big Bug company has shipping-ore ready to break at this property, in old workings, that will run better than 15% copper. A rich surface-strike is reported that is 10 ft. wide and can be traced across the property 3000 ft. It is believed this company will develop a large producer at this Copper mountain camp with very little additional development work, for the ore is found at the surface with practically no overburden. On the company's property adjoining the Blue Bell mine, a shaft has been sunk 250 ft., which is nearly through the iron-cap, under which the Blue Bell orebodies lie.

The Big Reef company has found good shipping-ore in new work on a property two miles from Mayer. Extensive development work is being carried on which is making a good mine out of a poor old property.



COPPER REGION OF YAVAPAI COUNTY, ARIZONA, FROM JEROME SOUTHWARD

It would be impossible to describe all of the mines and near-mines of this interesting district, for the reason that each day the work changes the previous day's report. Permanency of the orebodies has been established in several mines with workings from 600 to 1000 ft. deep. In the Blue Bell mine, for example, the main orebody is 40 ft. wide at the 1000-ft. level and shows double the width and value found when it was first opened. The ore of the district is amenable to the ordinary methods of treatment, smelting and flotation, as is shown at the Consolidated-Arizona smelter and flotation-mill. The shipping facilities of the district to company and custom-mills is excellent and climatic conditions are such that mining can be carried on every day in the year.

The building of a new railroad to Phoenix from Turkey siding, as contemplated by a newly organized company, would greatly benefit this district. It has already stimulated activity along the course of the survey, several properties having been bonded, and some sales actually made in anticipation of the railroad project going through. Such a railroad would serve a rich mining region. There is no question but that sufficient tonnage can be developed to supply the smelter, which is contemplated as part of the building plans. Mayer would be placed on a main line of railroad, and being far enough away from any other town of any size, would naturally become the principal place of business between Prescott and Phoenix.

MANHATTAN, NEVADA

IMPORTANT DEVELOPMENTS IN SEVERAL MINES.—THE WHITE CAPS MILL NEARING COMPLETION.—HIGH-GRADE ORE IN A NUMBER OF PROSPECTS.—FOSSILS IN THE PLACERS.

J. A. Cole, mine superintendent at the White Caps, reports that the shaft has reached a depth of 67 ft. below the fourth level. This represents an advance of 22 ft. for the week, good progress in sinking a double-compartment shaft. The flow of water in sinking is not over 2000 gal. in 24 hours. The sinking-pump, ready for use, so far has not been in operation, as the bailing takes little time and is less trouble to the crew than the large sinker. The ground through which the shaft is being sunk is a hard cherty material, but breaks well. The excessive flow of water in the east-drift work from the third level has not diminished. It was fortunate that the flow was struck in the middle of the shift, for if the water had not appeared until the round was shot, probably the entire lower workings would have been flooded and great damage done. The water was struck in a cut drill-hole and was plugged before the sump was filled. A 4-in. pipe with a pressure-valve has been put in. At present, there is 65 lb. pressure on the valve, in five minutes after shutting off the flow. The water is siphoned from the third to the fourth level, where it is picked up by the large station-pump, and by using the auxiliary station-pump intermittently, the water is kept under control, and none escapes into the shaft. The present flow handled by the pumps averages 200 gal. per minute. Similar flows of water have been encountered in running the drifts, just before striking the orebodies. A flood-gate is being installed in the west drift on the third level, as the management believes in preparedness. In the construction work in the White Caps mill, the roaster-shell has been completed. The form for the brickwork for the first hearth also has been finished. When complete the furnace will have seven roasting-hearths and one drying-hearth. The roaster is expected to handle approximately 125 tons for each 24 hours of White Caps ores. The maximum capacity is 175 tons, the difference in tonnage handled depending on the heat required in roasting the ore, a dead roast naturally requiring more time to each charge of ore. The mine ore-bin has been completed, and a Dodge crusher is installed close to the collar of the mine. The crusher building, 20 by 60 ft., is in process of erection. The main belt-conveyor is complete, and this finishes the installation of all the belt-conveyors with the exception of a short section to the roaster which soon will be finished. The new wagon-road to Pipe Springs from the White Caps has been completed to the first summit.

The shaft of the Morning Glory has reached a depth of 90 ft. The superintendent, Mr. Nelson, states that the formation in the bottom of the shaft is broken limestone. The value, which has shown for some distance in the shaft, is steadily increasing as depth is gained, and a vein carrying payable ore may be cut at any time. In addition to sinking, two shifts of miners are employed in prospect work from the bottom of the old Nelson Lease shaft. This shaft is 75 ft. deep and is between the company shaft and the White Caps west side-line. Considerable trenching has been done by the company along the breaks showing on the surface. To be able to carry on extensive work the management plans to make a change in the hoisting-equipment, replacing the 20-hp. hoist with a 40-hp. electric-hoist and motor. In addition, an air-line will be laid to the Consolidated mine-plant, when sufficient air will be available to operate two drills. Two jack-hammer drills have been ordered.

In the Manhattan Consolidated workings, on the 300-ft. level, 71 ft. east from the shaft, the fault, which has been defined both in the upper levels of the present working-shaft and in the workings from the old shaft, was struck and the face of the drift is now into the fault-zone 10 ft. It is impossible to state definitely its width, as the various places where cross-cut it has shown a width of from 10 to 40 ft. The orebody is known to be directly in contact with this in the old workings. On the 200-ft. level, the fault strikes north-south, and the orebody ends when the fault is reached. On the present 300-ft. level the fault recently cut strikes east-west, parallel with the vein. Due to the loose broken-up condition of the fault the progress is slow, as every foot of the cross-cut has to be heavily timbered. There is but little water thus far. The showings of sulphide-ore in the bottom of the west winze from the main workings of the Train Chase lease, on the Mustang claim, still appears strong as the winze is being sunk. Work has been concentrated in this winze, as the sulphide ore is considered as more permanent and the value of the ore is higher than when the ore-chimney was first developed. Samples taken from the bottom of the winze, a depth of 18 ft. since finding the high-grade sulphides, show $600 per ton gold. The ore-chimney is close to the contact, although all sides are still in the limestone. The schist hanging wall is distant 8 ft from the ore. As this rich ore is broken it is sacked and shipped to the smelter.

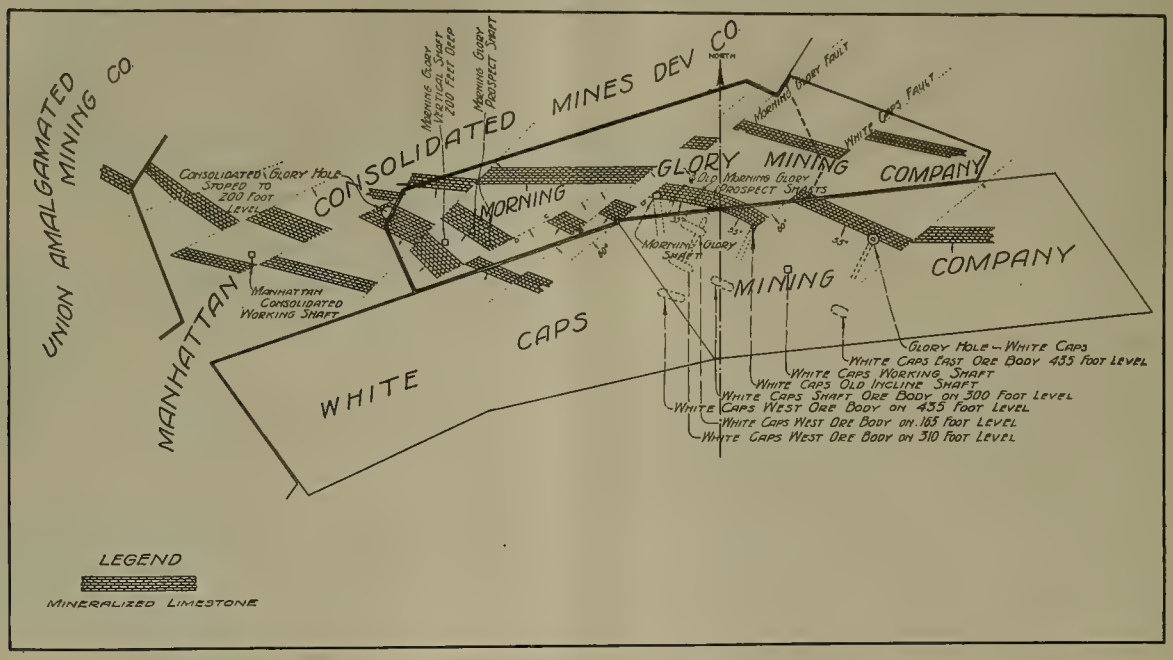
Recently some interesting fossils have been found in drifts in the deep-placer in the Searchlight claim, in the main Manhattan gulch, three miles west of the town. At a depth of from 70 to 80 ft. several large partly fossilized bones have been uncovered. One in particular, a portion of a shin-bone, was 15 in. wide and nearly 2 ft. long. This specimen was sent to the Smithsonian Institution. The latest specimen unearthed was a horn thought to be from a species of buffalo, not of large size but well preserved, and with curious deep indentations and ridges lengthwise of the horn.

The shaft of the Red Top has reached a depth of 85 ft. In the bottom of the shaft there is a change of formation from the lime-shale into massive limestone, in which the vein-system that follows the limestone has been proved on both sides of the Red Top workings.

At the Union Amalgamated property, from the 600-ft. level, the east drift has advanced 32 ft., now a total of 210 ft. from the shaft. During the week there has been some machinery break-downs which has decreased the footage usually made. Work is being concentrated in the east drift with three shifts. The flow of water from the east drift has lessened and no further delays from that cause are anticipated. The company mill has been supplied with ore from development work and some tonnage has been mined from the west orebody, which

contains high-grade ore but is irregular. It has been necessary to employ ore-sorters, by which means a good milling-grade of ore has been obtained.

The east drift has been run on a fault-plane and has been in low-grade ore for several feet. This fault cuts the limestone bedding-planes diagonally. To cut the downward extension of the free-milling orebodies developed in the upper levels of the Earl claim it will be necessary to leave the fault-plane and take a more south-east course. These orebodies have yielded a large tonnage of good ore from the Earl workings. The Swanson lease, which first developed them, has a record of having yielded $50,000. The ore averaged over $25 per ton in the mill. The width of the Swanson orebodies in many places was close to 25 ft. The milling of the ores extracted during development work is paying mine and mill expenses.


UNION AMALGAMATED MINING CO.
CONSOLIDATED MINES DEV CO
MORNING GLORY VERTICAL SHAFT 200 FEET DEEP
MORNING GLORY PROSPECT SHAFT
MORNING GLORY FAULT
WHITE CAPS FAULT
CONSOLIDATED GLORY HOLE STOPED TO 200 FOOT LEVEL
MORNING
GLORY MINING COMPANY
O.D. MORNING GLORY PROSPECT SHAFTS
MORNING GLORY SHAFT
MINING
COMPANY
MANHATTAN CONSOLIDATED WORKING SHAFT
MANHATTAN
WHITE CAPS
GLORY HOLE — WHITE CAPS
WHITE CAPS EAST ORE BODY 435 FOOT LEVEL
WHITE CAPS WORKING SHAFT
WHITE CAPS OLD INCLINE SHAFT
WHITE CAPS SHAFT ORE BODY ON 300 FOOT LEVEL
WHITE CAPS WEST ORE BODY ON 435 FOOT LEVEL
WHITE CAPS WEST ORE BODY ON 165 FOOT LEVEL
WHITE CAPS WEST ORE BODY ON 310 FOOT LEVEL
LEGEND
MINERALIZED LIMESTONE

BLOCK-FAULTING AT MANHATTAN. THE ORE IS FOUND ALONG THE FAULT-PLANES IN MOST OF THE MINES

The cross-cut in the Amalgamated Extension property reached the lime-belt on May 20, and has since been advanced 7 ft., cross-cutting the bedding-planes of the limestone. Driving is now in progress, to get under the ore-shoot, which shows a strong outcrop. In a small break in the limestone in the face of the drift the ore gives good pannings of coarse gold. It is probable that this streak will lead to the main orebody, which is expected in about 26 ft. in advance of the present face. A second shift of miners has been added to the crew of the Extension, which should make the average advance of the drift about 7 ft. per day.

SUTTER CREEK, CALIFORNIA

EXPANSION OF THE CLAY INDUSTRY NEAR IONE.—MORE TAILING TROUBLE FOR THE DEEP GOLD MINES.—HIGH-GRADE ORE NEAR COPPEROPOLIS.

Work on the clay deposits in the vicinity of Ione is progressing satisfactorily. A. B. Wallen is opening up a fine body of clay near the Dutschke place; tests show his shipments to be of standard quality and he has no difficulty in marketing his product. M. R. Bacon, superintendent for Clark & Sons, announces that he is nearly through stripping and will begin digging clay very soon; as there is a large demand for this clay. He is making arrangements to handle a greater output than ever before. The Theo. Dittell Co. has met with some difficulty in securing the desired site for its factory, at Carbondale, but this doubtless will soon be adjusted, enabling the company to carry out its plans for the manufacture of chinaware from the kaolin mined on the Clark & Sons ranch and the Amick pits. In view of the valuable glass-sand, also mined on this ground, considerable interest is taken in the fact that Eastern parties have just bought a half interest in the Patterson Glass Works, at Stockton, for $75,000. In the past six months the production of window-glass by that company has totaled about $350,000, and it is claimed that no finer sand for their purpose is found anywhere than that at Ione, the supply of which is very large.

Protests against the filling of streams by means of sand from the mills in this county have been made in letters addressed to several of the mine owners by the Corps of Engineers of the United States. The impounding-dam of the Kennedy company became undermined, permitting some of the tailing to escape. A break in the Central Eureka tailing-dam also has caused trouble, but steps are being taken to remedy this difficulty. The Keystone and Original Amador Mining companies were permitted to resume operations upon giving bonds for the prompt repair of their impounding-dam on which work is now under way.

The extended delay in the receipt of some of the electrical equipment for the Old Eureka hoisting-plant has so far prevented putting the new hoist and head-frame into service, and the temporary hoisting-equipment continues in use. Everything is in readiness, however, including the installation of the new hoisting-cable, so that after the arrival of the delayed parts, no time need be lost. The machinery in question was ordered over a year ago. In the meantime, the work of cleaning out and repairing the levels continues steadily and sufficient pay-ore has been found in sight to assure the future prosperity of this old mine.

In Calaveras county the Royal Consolidated Mines, at Hodson, will shortly resume operations, as all indebtedness has been paid off. W. A. Bret, of Boston, the president of the company, has just spent a couple of weeks on the property.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

Many of the copper mines of the world also produce a large amount of silver, and a few of them produce some gold. The following shows the silver production of a number of so-called copper and zinc producers during the past two years (in ounces):

	1916	1915
Anaconda	11,837,769	9,005,617
Butte & Superior	3,669,950	3,385,164
Calumet & Arizona	1,863,149	1,381,077
East Butte	556,542	318,124
Greene	1,881,816	635,997
North Butte	1,047,063	940,631
United States Smelting	11,647,205	12,071,863
Utah Cons.	558,845	370,985
Utah Copper	461,596	371,712

ARIZONA

Cochise County

(Special Correspondence.)—The increase of the present capalization of $3,500,000 to $5,000,000, par value of shares $10, will give the Denn Arizona the funds it needs to fully open the mine, which was closed in 1912 because of excessive overhead charges following the large increase in the inflow of water on the 1600-ft. level. The Junction, sinking to the 2000-ft. level has since shown that the water problem can be overcome through co-operation with the Calumet & Arizona. The Denn should be a large producer in 1918. The control of this property at present rests with the interests in control of Shattuck-Arizona. Calumet & Arizona, however, is understood to own a considerable block of the Denn shares. The new issue will be offered to present shareholders. Any part they may not subscribe for will go on the open market.

Bisbee, May 18.

Mohave County

(Special Correspondence.)—For the first four months of operation, the United Eastern mill treated 22,473 tons of ore having a gross value of $504,615.47, being an average of $22.35 per ton. Average extraction for the entire period was slightly under 96%, and working costs and losses averaged $8.28 per ton. The total net profits totaled $311,774.09.

The total number of tons milled per month for the period increased from 3800 in January, to 6706 in April, and May will exceed that amount. With the mill now in perfect running order it is expected that the daily average of 225 tons, established in April, will be maintained or perhaps exceeded.

F. O. Altinger, an assayer, has been arrested, charged by superintendent Burgess of the United Eastern with having received stolen high-grade ore from that mine, valued at several thousand dollars. He is alleged to have a complete milling and cyanidation-plant, in which the gold was extracted. The high-grade ore from the United Eastern runs from $1 to $5 per pound in gold, though the seam containing such value is narrow.

The new Tom Reed 300-ton Allis-Chalmers ball granulating-mill was started Saturday, May 26, and it demonstrated its efficiency by grinding nearly its full capacity from the start. Ore is being brought down from the Aztec shaft by auto-trucks pending the installation of the 4000-ft. tramway which is being erected.

The Gold Road mine is being rehabilitated, and the mill put in order. A vein of ore 4 ft. wide, 400 ft. long, and 400 ft. in vertical depth is being opened-up and blocked-out. In addition to this orebody, the drift is being extended east on ore and a winze is being sunk from the 400-ft. level in ore assaying between $15 and $20 per ton. Experiments have been conducted with the flotation-process at the Needles smelter of the U. S. Smelting, Refining & Mining Co., but so far without proving that oil-flotation will work successfully and profitably with ore from the Oatman district, which is entirely free from sulphides and essentially a cyanidation ore.

A demand for higher wages on the part of the miners employed in the district has been rejected, but a counter proposition, offering a sliding-scale and an increase of about 25c. per day has been made by the operators.

Oatman, May 29.

CALIFORNIA

The State supervisor of oil and gas reports to the State Mining Bureau for the week ended May 26, 38 new wells started, making a total of 471 since the first of the year; 26 wells ready for test of water shut-off; 13 deepening or re-drilling, and four wells abandoned.

Calaveras County

(Special Correspondence.)—At the Mokelumne Hill group sinking continues, the shaft is down 350 ft., and the ore is improving with depth. The mill is running on ore from the west stopes.

Mokelumne Hill, May 28.

(Special Correspondence.)—P. B. R. Lightner, of Stockton, has re-opened the La Petite mine near Railroad Flat, and sinking is in progress, now down 100 ft., with good free-milling ore in sight.

Railroad Flat, May 28.

Fresno County

(Special Correspondence.)—The Copper King mine under the new management, has made its first shipment of 25 tons of 10% ore to the Mammoth smelter, and shipments are to be continued regularly. C. D. Demarest, of the Angels Iron Works, is manager. The company is headed by B. N. Garrett, president of the Houston Bank and Trust Company, of Houston, Texas. The Copper King mine was operated from 1889 to 1893 and was equipped with a smelter, situated at Seal Bluff landing, on Suisun bay. Operations under the old company were disastrous, but under existing conditions and shipping to a custom-smelter the enterprise has entered on a career of prosperity. Ore is being developed in the mine, and a large tonnage is said to be available.

Fresno, May 31.

Shasta County

(Special Correspondence.)—The Mammoth Copper Co. is devoting much attention to outside properties with gratifying results. Shaft-sinking at the Stowell is proceeding steadily with a view to opening the orebodies to considerable depth below the developed area. The Donkey mine, adjoining the Afterthought, near Ingot, has been equipped with an electric-hoist and the shaft is being deepened. The Friday Lowden is receiving attention, and considerable work is being done on claims adjoining the main Mammoth mine. Three furnaces of the Kennett smelter are kept in constant operation, and preliminary trials are being made with the new electrolytic zinc-plant.

The Arps Copper Co. has placed orders for a hoist, compressor, power-drills, and other equipment, and is preparing to

sink the shaft deeper and start comprehensive lateral development. The superintendent expects to increase the working force shortly, and satisfactory deep explorations will likely result in the installation of a flotation-equipment. The mine adjoins the Bully Hill group, near Winthrop, and contains high-grade copper ore, some of which is rich in silver.

The Bell Cow gold property, near Ono, has been taken under bond by C. L. Wilson and vigorous work started. The mine has been developed from a prospect into a promising property by T. P. Ames and Frank A. Greene, of Ono. Wilson developed the Arps copper mine from a prospect into a good producer, and also rehabilitated the old Texas group, near Whitehouse.

Dewatering of the Midas mine, at Harrison gulch, is proceeding steadily, and the management expects to start extensive development below the 1000-ft. level before summer ends. Some work is going forward in the Gold Hill mine and upper parts of the Midas. All mine equipment is now electrically operated and the numerous troubles caused by unsatisfactory steam-equipment has been eliminated.

Kennett, May 30.

Trinity County

The Trinity Star Mining Co. is building a dredge to cost $125,000. It will work on the Paulsen ranch near Lewiston.

Tuolumne County

(Special Correspondence.)—The Buchanan mine, on the high divide between the Main and South Forks of Tuolumne river and an early-day producer, is to be re-opened by the Buchanan Consolidated Mines Co., which has just been incorporated under the laws of Nevada. The authorized capital of the company is $1,000,000, with shares at $1 each. The incorporators are F. M. Carter and Fay Chadbourne, of Oakland; F. R. Vincent, of Alameda; L. E. Carter, of San Francisco, and C. W. Mitchell, of Pasadena. The amount to which the company may become indebted is limited to $125,000. Besides having a good record to its credit, it took a spectacular place in local mining history years ago, when a large number of Chinese employed in the mine were marched out from the property by a body of armed men that had been organized in Sonora.

A new mill, the invention of O. A. Ellis, has been installed at the Chaparral mine, which adjoins the Buchanan on the south, and will make its initial run shortly. Crushing is done by iron balls weighing 450 lb. each, rolling on a concave circular track, the balls being propelled by a revolving grooved circular top. It is claimed the mill, which can be operated with 5 hp., will have a capacity of 25 tons daily

An option on a tract of land near Rawhide, owned by John Madrid, has been given to Harry C. Warwick, of San Francisco. The property is said to contain valuable magnesite and chrome ores.

A vein of rich ore, 8 in. wide, has been uncovered in the Hand Over mine, near Arastraville, under lease and option to Messrs. Headrick, Wilson, and Gianelli.

It is expected that operations will be resumed at the Clio mine, at Jacksonville, early in June.

An outside company has taken a bond on the Italian Camp group of mines, 5 miles east of Columbia, and it is understood active operations will begin at once.

Sonora, May 28.

NEVADA

Clark County

(Special Correspondence.)—This week an important strike was made in the Yellow Pine mine which is equivalent to the discovery of a new mine. It is on the 700-ft. level in a part of the mine heretofore never prospected and the lead and zinc content is somewhat higher than the average run-of-mine ore, being 18% lead and 35% zinc, and carrying approximately 30 oz. silver per ton. This amount of silver is unusual in the Yellow Pine ore. A cross-cut in this ore is now out 40 ft. and still in ore.

C. A. Overmire of the Pacific Platinum Works is conducting a series of large-scale tests on the copper-platinum-palladium ore in the old stopes and on the dumps at the Boss mine. This ore was mined before the rare metal content was known.

Until a tram can be installed at the Platino mine the copper ore is being packed down the hill by burros. Every four-footed long-ear in the district has been commandeered.

Of the new dry-concentrators, the Christmas Consolidated is of especial interest, due to the high-grade product it is turning out from a rebellious ore.

The Goodsprings Sampling Works, at Jean, on the Salt Lake road was inspected by J. M. Bidwell, general manager for the Garfield Smelting company, last week. A great advantage of this plant to the district is its facility for handling small shipments for lessees. Some of these receiving settlement for cars last week were Gallagher & Reid; Blackburn, Becraft & Smith; S. C. Root; and the Christmas Consolidated.

E. S. Armstrong, of Pasadena, California, who recently purchased the Hoosier mine, has discovered that the lead ore has an appreciable amount of lead molybdate. It is probable that considerable of this has been shipped with the regular lead shipments.

Moapa reports the discovery of oil. It occurs at a depth of 2000 ft. and, while not a large flow, is of excellent quality.

Goodsprings, May 28.

Esmeralda County

(Special Correspondence.)—Stoping of shipping-ore has begun in the south drift on the 840-ft. level of the Kewanas, and A. I. D'Arcy, the manager, expects to start shipments in a few days. The south drift has been in ore for 100 ft., the vein ranging from 2 to 4 ft. wide. Shipping material is exposed in the north and south parts of the property, with approximately 1200 ft. of the main orebody yet to be explored between these points. The development of flotation-ore is also proceeding.

The Red Hill Florence Co. has re-timbered its 800-ft. shaft to the 500-ft. level and installed a 60-hp. electric-hoist. Arrangements are being made to drive north and south from the 500-ft. level to develop the orebody opened on the 200-ft. level by the north-west cross-cut. As soon as this work is completed cross-cuts will be run to find the Florence vein.

The Great Bend is producing a small tonnage of ore assaying $26 to $30 per ton in gold. The best ore is coming from stopes above the 160 and 300-ft. levels. Considerable milling-ore has been recently exposed and as soon as a sufficient tonnage is blocked out the small mill will be overhauled and placed in service.

The Sunset Mining & Development Co. is preparing to repair the 600-ft. shaft on its Denver claim, and to sink it 100 ft. deeper. Good ore is stated to be exposed at the 600-ft. point and extensive development will be done on this level. It is stated by the owners that large quantities of ore assaying $10 to $20 per ton are exposed in the old workings, and on the dumps. Sufficient water to operate the enlarged mill has been secured. The property is near Rhyolite.

The Mount Montgomery Mercury Co. has been organized by Goldfield men to work a group of cinnabar claims west of Belleville. Ore of excellent grade is said to be exposed. F. C. Beedle is president, and A. J. Bogard, Jr., secretary.

Goldfield, May 28.

Nye County

(Special Correspondence.)—The work of unwatering the old Tybo mine by the Louisiana Consolidated Mining Co. was started May 26. Two big Cameron pumps were put in operation, the power being furnished by the auxiliary steam-plant, as the 24° fuel-oil for the Diesel engine has not yet been delivered. The shaft is now 425 ft. deep and the water reaches the 300-ft. level. When the water is out, sinking to 800 ft. will begin and the development of the mine to that level will proceed. As shown by the report of John B. Farish, and others, the ore on the 400-ft. level is 64% richer than above and it is

believed that the vein will go to great depth. The vein accompanies a nearly vertical porphyry dike cutting horizontal limestone beds. The Louisiana company has a prospector in the field and he has found a likely looking prospect eight miles south of Tybo. The pay-streak is eight inches wide and the first sample went $70 per ton in silver.

Tybo, May 29.

(Special Correspondence.)—What appears to be a phenomenal strike of gold ore has been made in the War Eagle group of mines in a range of high hills three miles east of the old camp of Goldyke. At Luning and Mina nearly every man has a specimen of the ore, some of them containing hundreds of dollars in visible gold. An option was given on the property for several thousand dollars, and the parties holding the option are said to have taken out more than the price agreed upon by merely prying and gadding off a few slabs of rock matted with gold in a shallow cut. A stampede is in progress and the entire country is being staked and re-staked. The prospects for personal encounters are considered quite as good as for high-grade ore, under the stimulus of the present excitement. The strike is described by an engineer who just came in from the district as being on a contact of lime and rhyolite. High-grade copper ore, mostly chalcopyrite and glance, occurs on several claims. High-grade galena, some of it solid with silver, also occurs.

Luning, June 2.

The Tonopah Extension company reports the net earnings for April at $34,248.46. The Tonopah Belmont bi-weekly clean-up, May 25, is reported as valued at $144,780.

NEW MEXICO

Socorro County

(Special Correspondence.)—A new strike has been made at a depth of 200 ft. in the Lynchburg mine under the control of the Empire Zinc Co. This is one of the Kelly mines that has not been operated for some time. The strike is a massive copper sulphide carrying from 15 to 20% copper.——Some Tulsa, Oklahoma, capitalists have formed a company to develop the Lone Tree group of mines, about three miles from Magdalena, and work has been commenced. New air-compressors and drills have been ordered and will arrive this week. This property gives promise of becoming one of the best producers in the vicinity. The Buckeye Copper Co. is doing a large amount of development at its properties near Water Canyon in the Magdalena-Kelly district. Over 20 men are employed in installing the new machinery. The new equipment includes a 100-hp. Sullivan air-compressor and a steam-hoist with a capacity of three tons from a depth of 1500 ft. An Anaconda hoist has also been installed in the mine.——A wage increase of approximately 25% has been granted the workmen at the Kelly mines. The increase was allowed without any labor agitation whatever, the necessity for calling a strike, or a break in the friendly relations between the employer and the employees.——P. H. Argall, the superintendent, and Ricarte Montoya carried on the negotiations, which resulted in the desired raise.

Magdalena, May 26.

OREGON

Curry County

(Special Correspondence.)—The Blanco mine, commonly known as the Madden property, has been taken over by L. B. Newby and associates, of New York. This property, an old-beach deposit, is about half way between Port Orford and Langlois, at the foot of Madden butte. The mine was formerly worked by Cyrus Madden and was equipped with 500 ft. of sluices, with seven burlap-covered tables for saving fine gold and platinum. The gold and platinum-bearing material consists of 12 to 20 ft. of sand in which are several layers of black-sand. There is a little small gravel interstratified with the sand, the metal-bearing strata being covered with 7 or 8 ft. of worthless wind-blown detritus. The bedrock is shale, but lies a few feet lower than the natural drainage. It is said the mine, when worked about 6 months annually, has paid over $1000 a year, though it operates in a small way. It is the intention of Mr. Newby to put in a plant that will treat 500 tons per day, which will greatly increase the output and enable the work to be accomplished at a cost much below that heretofore obtaining. It is beleived that when suitable machinery has been provided to work the sand below the level of the present natural drainage, the value of the material handled will show a substantial increase in value per ton. The property covers a large area of workable material.

Bandon, May 30.

Jackson County

(Special Correspondence.)—W. H. Gore, president of the Medford National Bank, with several other local capitalists and a Portland auto-truck company, have submitted a proposition to the Blue Ledge Mine Co., by the acceptance of which it will be able to ship from three to five carloads of ore per day, instead of three weekly, as heretofore. The mine is situated 30 miles from Medford. The owners began shipping ore last December, employing all the available teams and trucks in the valley, paying as high as $10 per ton for the haul to the railroad. The object is to put on about 50 auto-trucks and convey the ore from the mine to the railroad as fast as it is extracted. More trucks will be added if necessary. A feature of the plan will be to expend about $10,000 on the road in conjunction with an equal amount furnished by the county. The total cost to the proposed truck-company would be in the neighborhood of $50,000.

Should the development of the mines adjacent to the Blue Ledge, and in other camps of that district, as now contemplated, justify it, the new transportation company will eventually build a railroad into that region, to handle both its mine and timber output, and to use the auto-trucks on feeder-lines.

In this manner Mr. Gore and his associates hope to be able to solve the transportation problem, lack of a solution of which has so long retarded the development of several rich mining districts immediately tributary to railroad transportation in this valley.

Gold Hill, May 29.

Josephine County

(Special Correspondence.)—Eleven copper claims on Fall creek, in the Upper Illinois district, 13 miles north-west of Selma, known as the United Copper-Gold Mines property, were sold this week to R. J. Rowen, representing Eastern capital, by W. S. Low, Daniel Webster, and C. E. Lebold, of Salem. The property is an old producer and is known as one of the high-grade properties of this county. It shipped ore in the early days by way of Crescent City, and later to Martinez and Tacoma. Shipment was made by pack-horses, wagon, and railroad.

Building the new wagon-road to the chrome mine, four miles this side of the property, solves the transportation problem. The new owners will begin shipments promptly upon the completion of this road on which 165 men are employed. Mr. Rowen has also closed deals for the Katy Ayers and Emerald groups of copper claims on Rancheria and Cedar creeks, smaller and less developed properties.

Grants Pass, May 28.

SOUTH DAKOTA

Lawrence County

The Homestake Mining Co. has received an order for 90 tons of tungsten concentrate, one carload of which has gone out. Another car is being loaded and a third shipment will leave Lead by the middle of June. The Homestake continues to produce a high-grade concentrate. The mill is working satisfactorily and a steady supply of ore is coming from the

mine in West Lead. The old dumps have been practically cleaned up, the greater part of the ore production coming from the mine, where the veins hold out well and give promise of long continued production.

The Homestake Mining Co., having decided to pension some of its employees who, because of old age or physical disability, are no longer fitted for the proper discharge of the duties assigned to them, has sent out notices to 26 such employees, advising them that the proposed pension-system will go into effect on July 1 of this year. Eligibility to the pension-list is not based on long service with the company, as some of those who will be retired have worked comparatively few years; one of them at least having been on the pay-roll only six years.

The pensioners will receive 25% of their last year's pay, plus $10 for each year they have been in the employ of the company; thus, a man whose total pay during the last year of his regular employment amounted to $1000, would get 25% of this, or $250, and in addition, if he had worked 20 years for the company, would receive $10 for each of these years, or $200, making his total year's pension $450.

No pension of more than $600 will be paid. The pensioners are not prohibited from doing work for themselves and many of them will be able to add materially to the amount paid them each year by the Homestake company.

The management of the Homestake company has compiled a census of the men in its employ who are eligible under the provisions of the selective-draft section of the army-bill. The list shows that something less than one-third of the employees, or 710 men, come within the age limits, and are divided among the different departments as follows:

Mine	488
Wood and timber	18
Machine-shops	14
Foundry	16
Homestake mill	12
Amicus mill	8
Electrical department	12
Water department	10
Blacksmith shop	10
Slime-plant	10
Assay-office	9
Survey department	7
General supplies department	6
Scattering	90

Of the 710 eligibles, 461 are single men and 216 are married. Thirty-three have not taken out citizenship papers.

TEXAS

Bexar County

(Special Correspondence.)—C. L. Baker, who is making a geological survey of this part of the State for the Bureau of Economic Geology and Technology of the University of Texas, has discovered, near here, a large deposit of bentonite, a peculiar and valuable clay, that has heretofore not been known to exist outside of Wyoming, in this country. One of the valuable physical properties of bentonite is that it is capable of absorbing large quantities of various liquid substances. It is put to many uses, among them being in the manufacture of a medical dressing, known as antiphlogistine. Its chief use, however, is to give body and weight to paper. It is also used as a soap-filler in the manufacture of high-grade soaps; to dilute powerful drugs, that are sold in powdered form, and as an adulterant in candy. Steps are to be taken toward developing the deposit on an extensive scale.

San Antonio, May 20.

El Paso County

(Special Correspondence.)—Unusual activity in mineral exploration and in the development of existing properties is reported from the different districts of west Texas. It is announced that the Tama Silver Mining Co. recently uncovered a large body of zinc carbonate on its property in the Quitman district, near Sierra Blanca. It is claimed that the ore averages 20 to 40% zinc. The surface outcrop has been explored to shallow depth and there has already been exposed in the workings more than 15,000 tons of ore.

The Hazel Silver Mining Co., which operates the old Hazel copper mine, situated 18 miles north-west of Van Horn, will soon install a cyanide-plant. O. W. Steel is manager.

Edwards & Bright are developing a promising copper property three miles south of Allamore.

Love Bros. soon will begin making regular shipments of silver and lead ore from their mine, nine miles south-west of Sierra Blanca. The Bonanza mine, also situated in the Sierra Blanca district, is being developed by Thomas and Rowdy Love. This property has produced a large amount of high-grade silver-lead and zinc-sulphide ore. Love Bros. soon will build a 75-ton mill on the property.

The Lulu B mine, which is owned by the Lulu B Mining Co., and located in the Sierra Blanca district, is making a good showing of argentiferous lead carbonate and molybdate of lead. W. W. Crosby is manager.

Alpine, May 21.

UTAH

Tooele County

The Deep Creek railroad has announced a new time-schedule from Wendover to Goodwin. The new schedule, which includes both freight and passenger, provides several trains each way per day. The freight-service has been adjusted to meet requirements of new machinery shipments for the Queen of Sheba, Woodman, and other properties under re-construction in the district.

J. B. Reid, mill-superintendent for the Queen of Sheba Mining Co., is remodeling the mill. He will remain on the property until he has brought it up to modern requirements.

ALGERIA

The Beni-Felkai Mining Co., Ltd., of London, has been granted a concession to carry on iron-ore mining near Takitount, in the Constantine Department of Algeria. The terms of the concession are reported to provide for payment to the Algerian government of a royalty of 4d. per metric ton of ore used or sold by the company.

CANADA

Ontario

(Special Correspondence.)—During April the Nipissing Mining Co. mined ore of an estimated value of $259,082 and shipped bullion from Nipissing, and customs ore, of an estimated value of $517,719, making in all a little over $750,000. Results for the month, although devoid of unusual features, were satisfactory. The high-grade mill treated 171 tons and shipped 703,756 oz. of silver. The low-grade mill treated 5829 tons of ore. The following is a summary:

Washing-plant	$129,792
Low-grade mill	129,290
Nipissing and customs ore	517,719
Total	$776,801

Cobalt, May 10.

The gold and silver mines of northern Ontario in 1916 paid dividends to the amount of $76,956,790.

MEXICO

Nuevo Leon

(Special Correspondence.)—The revival of mining and smelting in Mexico is due to the restoration of peace and order in many of the ore-producing districts. The Compañia

de Minerales y Metales, which is one of the largest American owned companies operating in this country, has re-established its headquarters here, and has reorganized its working forces at its different mines and expects soon to bring its ore output up to what it formerly was in normal times.

There has arrived here a party of officials of the American Smelting & Refining Co., headed by the general superintendent, A. McL. Hamilton, of San Francisco. They will visit the smelters and mines of the company at Matehuala, the smelter at Aguas Calientes, and give attention to the details connected with the re-opening of these properties. The several plants will be in full operation, it is stated, by June 1. The work-men have been brought from Chihuahua, where they were employed in the smelter of the company near that city.

It will probably be several months before all of the twelve large smelters in Mexico are again in full operation, even should there be no revolutionary disturbances in the meanwhile. It is necessary to bring in large shipments of coke and to do this, additional equipment will have to be provided by the railroads. Coke is now being imported from Birmingham, Alabama, by way of the port of Tampico.

Before the general cessation of mining operations in this country there were being produced here approximately 160,000 tons of ore each day which required for transportation about 6400 cars. The large smelter at Torreon, which is owned by the Madero interests, has been operated from time to time during the last two or three years for the benefit of the Carranza government. It is reported that it will soon be turned over to its owners and again placed in operation.

Monterrey, May 17.

SINALOA

The Jesus Maria y Anexas, at San José de Gracia, is being operated by its Mexican owners. This is the famous gold mine formerly belonging to a company controlled by leading men in the Calumet & Hecla corporation. Guadalupe de los Reyes, belonging to a Spanish concern, is intermittently running, and the well-known Minas del Tajo, at Rosario, is milling a small tonnage, activity at both these mines being limited for want of cyanide. The Pánuco in the district of Concordia, a silver mine that has yielded large sums to its original Mexican owners, is now being worked by the Government. The only other important mines in the State which are operating are the Potrero and the Palmarito close to Mocorito. E. A. H. Tays is developing a copper mine near San Blas. Across the boundary line, in western Durango, the mines at San Dimas are treating a fair tonnage and the San Fernando is taking out shipping ore that is being sent to the Copper Queen smelter at Douglas, Arizona.

KOREA

The Oriental Consolidated Mining Co. reports the clean-up for April as $125,000.

Underground developments at Tul Mi Chung continue to be satisfactory.

At the Suan mine a discovery of high-grade ore has been made. An average of 22 samples taken returned 15.02 dwt. gold and 2.18% copper per ton.

TRANSVAAL

(Special Correspondence.)—The following cablegram has been received at London from the head office in Johannesburg: "Annual revision of ore reserves in the Bantjes Consolidated Mines (Ltd.) has been made as at end of 1916, and gives the following results: Leader (including some Main Reef) 198,300 tons, value 5.8 dwt. over a stoping width of 44 in.; South Reef, 213,700 tons, value 5.5 dwt., over a width of 41 in.; total payable ore 412,000 tons, value 5.6 dwt. Comparing the reserves at the end of 1915, this shows a total decrease of 236,000 tons and half-a-pennyweight per ton in value.

Johannesburg, May 15.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

BEN. S. REVETT is in Idaho.

W. H. ALDRIDGE is in San Francisco.

R. L. GRIDER is in northern California.

J. PARKE CHANNING is at Portland, Oregon.

ALBERT BURCH has returned to San Francisco.

C. COLCOCK JONES was in San Francisco this week.

ALBERT L. WATERS has gone from Arizona to Philadelphia.

S. HERBERT-WILLIAMS, of Ely, Nevada, is at the Stewart hotel.

L. B. NEWBY has returned to New York from Curry county, Oregon.

FORBES RICKARD has returned to Denver from Lovelock, Nevada.

O. R. WHITAKER has returned to Denver from Chloride, Arizona.

COREY C. BRAYTON will be at Midvale, Utah, through the month of June.

W. F. STEVENS has returned to Long Beach, California, from Lovelock, Nevada.

BERNARD MACDONALD is going to Antofagasta, Chile, and will be absent several months.

H. R. NORSWORTHY has returned to San Francisco from Plumas county, California.

H. B. SHARPS, superintendent of the Big Casino Mining Co. at Searchlight, Nevada, is at Philadelphia.

EDWIN E. CHASE and son, on their return to Denver from Missouri, have gone to Yavapai county, Arizona.

ARTHUR C. TERRILL has returned to the University of Kansas from an inspection of the Augusta and Eldorado oilfields.

CLYDE R. WEED, formerly superintendent of the Lake mine, has been appointed manager of the Hancock mine, in Michigan.

R. E. VANDRUFF, president of the New Dominion Copper Co. recently inspected the property of this company at Globe, Arizona.

PHILIP N. MOORE has returned to St. Louis, having completed his visits, as President of the Institute, to the various western sections.

ALF WELHAVEN, resident manager for the Oriental Consolidated Mining Co., sailed by the 'Korea Maru', from San Francisco for Korea on June 5.

J. ED. SHARMAN, formerly with the Nipissing research staff at Cobalt, Ontario, has been awarded the D. S. O. for good work with the British Naval Flyers.

W. W. WISHON, consulting engineer for the Big Casino Mining Co., has been in Madera county, California, making an examination of the Mud Springs mine.

JOHN L. HARRIS has resigned as manager of the Hancock mine. Mr. Harris, like his father, has been long honorably identified with copper mining in Michigan.

D. D. HOMER, until February 1, general superintendent for the Butters Devisadero Company in Salvador, is now general superintendent for the Jerome Del Monte Copper Company at Jerome, Arizona.

M. L. FULLER, managing geologist of the Associated Geological Engineers, is conducting exploration work in West Virginia; C. T. GRISWOLD has gone to New York; ERNEST MARQUARDT is in Wyoming, and F. G. CLAPP, managing geologist, has just completed a monograph on oil and gas in South America.

H. A. PIPER, an engineer, long prominently identified with Rhodesian mining, notably as consulting engineer to the Globe & Phoenix Gold Mining Co., died of pneumonia in May shortly after his return to England from South Africa.

THE METAL MARKET

METAL PRICES

San Francisco, June 5

Antimony, cents per pound	23.50—25.00
Electrolytic copper, cents per pound	33
Pig lead, cents per pound	10.25—11.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$90
Spelter, cents per pound	11.50
Tin, cents per pound	65
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, June 5

Antimony, 50% metal, per unit	$1.70
Chrome, 40% and over, f.o b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tin, cents per pound	60
Tungsten, 60% WO_3, per unit	20.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 45% (under 35% metal not desired), cents, unit	36—38

Manganese prices and specifications, as per the quotations of the Carnegie Steel Co, schedule of prices per ton of 2240 lb. for domestic manganese ore delivered, freight prepaid, at Pittsburg, Pa., or Chicago, Ill. For ore containing

	Per unit
Above 49% metallic manganese	$1.00
46 to 49% metallic manganese	0.98
43 to 46% metallic manganese	0.95
40 to 43% metallic manganese	0.90

Prices are based on ore containing not more than 8% silica nor more than 0.2% phosphorus, and are subject to deductions as follows: (1) for each 1% in excess of 8% silica, a deduction of 15c. per ton, fractions in proportion; (2) for each 0.02% in excess of 0.2% phosphorus, a deduction of 2c. per unit of manganese per ton, fractions in proportion; (3) ore containing less than 40% manganese, or more than 12% silica, or 0.225% phosphorus, subject to acceptance or refusal at buyer's option; settlements based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken to be deducted from the weight Prices are subject to change without notice unless specially agreed upon.

EASTERN METAL MARKET

(By wire from New York)

June 5.—Copper is strong, with prices nominal at 32.50 to 32.75c. Lead is strong and advancing at 11.37 to 11.50c. Zinc is quiet and firm at 9.75c. Platinum is unchanged at $105 for soft and $111 for hard.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
May	30	Apr. 24	74.08
"	31	May 1	74.06
June	1	" 8	74.92
"	2	" 15	74.69
"	3 Sunday	" 22	74.78
"	4	" 29	74.62
"	5 Holiday	June 5	74.80

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	72.51	Oct.	49.40	67.86	....
May	49.87	74.27	74.61	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
May	30	Apr. 24	31.47
"	31	May 1	30.43
June	1	" 8	31.37
"	2	" 15	32.00
"	3 Sunday	" 22	32.25
"	4	" 29	32.50
"	5	June 5	32.62

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	33.16	Oct.	17.90	28.50	....
May	18.71	29.02	31.69	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

Dividends declared by the large copper companies in May were over $10,000,000, which was an increase of $3,400,000 over the dividends of May 1916. This was due chiefly to the fact that the United Verde Extension, the Shannon, and the Mass companies have joined the list of dividend payers since May 1916.

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	48.25	51.49	55.63	Oct.	33.00	41.10	....
May	39.28	49.10	63.21	Nov	39.50	44.12	....
June	40.26	42.07	..	Dec	38.71	42.55	....

Tin remains firm and though not maintaining its highest figure of last week, is now, May 29, quoted at 64¾ to 65¼c. for spot delivery.

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
May	30	Apr. 24	9.43
"	31	May 1	9.62
June	1	" 8	9.62
"	2	" 15	10.49
"	3 Sunday	" 22	10.50
"	4	" 29	10.93
"	5	June 5	11.46

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.04	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	8.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	9.38	Oct.	4.62	7.02	....
May	4.24	7.38	10.29	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

On June 4 the Bunker Hill & Sullivan Mining & Concentrating Co. paid dividend, No. 252, of $81,750.

On the same day, the company will pay an extra dividend, No. 253, of $81,750. These two dividends will make the total dividends paid to date $19,470,750.

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound

Date		Average week ending	
May	30	Apr. 24	9.58
"	31	May 1	9.23
June	1	" 8	9.61
"	2	" 15	9.37
"	3 Sunday	" 22	9.37
"	4	" 29	9.50
"	5	June 5	9.66

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	10.20	Oct.	14.05	9.92	....
May	17.03	16.01	9.41	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
May	8	113.00	May 22	95.00
"	15	106.00	" 29	95.00
			June 5	90.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	114.50	Oct.	92.90	78.20	....
May	75.00	90.00	104.00	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

Quicksilver has been exceedingly dull with very little business, and prices have been reduced to $90 per flask for virgin Californian, with Mexican selling around $85.

Platinum is quoted at $105 for soft unalloyed metal and $111 for the hard natural platinum-iridium alloy.

Tungsten: The past week has again seen considerable business in tungsten, and the New York market is practically bare of supplies for early deliveries. Not only our home market but foreign markets have again appeared as buyers, but it has been impossible to quote against all the inquiries received. The market is quite firm at schedule prices for American scheelite, with foreign ores of good quality selling at $20. The inquiries for ferro-tungsten for home consumption from Canada, Italy, and France are for very large quantities and the price rules firm from $2.25 to $2.50 per pound.

Molybdenum: Molybdenum ores continue in demand and business has been done at $2 per pound MoS_2 for 90% concentrate.

Manganese remains firm and in strong demand with $1 quoted for furnace-ore and 5 to 7c. for high-grade chemical ore.

The annual report of the International Nickel Company for the year ended March 31 shows earnings of $17,000,000 after deducting the cost of manufacture, selling and maintenance charges. Net profits of $13,558,000 enabled the payment of over $10,000,000 in dividends and the addition of $2,982,000 to surplus account, thereby increasing that item to $6,200,000, a figure nearly double the amount standing at the end of the previous fiscal year. Although more liberal in publicity than ever before, the management has never brought its annual reports up to date in the matter of information concerning actual operations. The International Nickel Co. looms as the largest nickel producer in the world, yet no idea as to its output of that metal ever appears in official data. The company also ranks among the largest copper producers of the Dominion of Canada, but no figures of production have ever been made public.

Cost items, such as make the perusal of a mining company report worth while, are conspicuous by their absence.

The attempts made lately to place further orders for ferro-manganese have elicited the fact that sellers have practically vanished. British producers are heavily sold ahead and it is much more difficult than before to obtain licenses. Inquiries are still coming in on Continental and trans-Atlantic account, but business is almost impossible. The tendency is undoubtedly much stronger, with f.o b. prices for loose ranging nominally from £40 upward. Bids of £41 and more from Spain have been refused, and it is impossible to furnish reliable quotations. There is a small business passing in Indian manganese ores, the negotiation of orders being handicapped by tonnage difficulties.

Eastern Metal Market

New York, May 29.

The principal metals continue to maintain their strength and most of them have advanced.

Copper is stronger with a firm undertone.

Zinc is steady and strong but not active.

Lead is very strong and advancing each week, with supplies rather limited.

Tin is quiet but strong with anxiety lessened by fairly large arrivals.

Antimony is easier and somewhat lower.

In the steel market the enormous volume of the purchases of steel by the Government is causing prices to go higher for the manufacturing consumers. The needs of the Government for sheets is larger than figured, and these have advanced about $5 per ton during the last week. Considerable interest is manifested in the coming award by the Government of contracts for 7,500,000 shells for field artillery, requiring about 50,000 tons of steel. A falling off in the needs of automobile companies for steel has materialized, makers of pleasure-cars having requested the holding of shipments in some cases, but Government buying of motor-trucks embraces 70,000 now under inquiry and more to come. Deliveries of nearly every form of finished steel become more difficult each week, as the Government demands preferential treatment for the movement of coal and iron ore.

COPPER

The market is growing stronger instead of weaker, despite the fact that very few sales are reported. Quietness generally prevails, and conditions are decidedly uninteresting. A little business in June-July delivery has been done, but the volume was not large. The metal is really scarce this side of August, and obtainable only from second hands, with many producers out of the market for June and July shipment. It is estimated that 5,000,000 lb. was sold last week for this position through dealers and outside holders, but this has not been confirmed. For metal desired after August 1, prices have stiffened if anything, third quarter being quoted at 30 to 31c., New York, for electrolytic, with July metal higher at 31 to 32c. The market is still influenced by the Government's probable needs and policy. No purchases from that source have yet been made, it is believed, nor are any expected for several weeks. Without doubt the impression is gaining force that each government will fare the same in its purchases, and that these will be made nearer the current level than in the case of the first lot sold at 16¾c. per lb. The quotation today for nearby Lake and electrolytic is 32.50c., New York. The London market for spot electrolytic is apparently unchanged at £142, the last quotation made on Saturday, yesterday having been a holiday there.

TIN

Opinion in the trade as to whether the proposed Government duty will be put on tin seems to be divided. Some think a duty of fair proportions will be levied, but the majority appear to contend that tin will finally come in free of tax or duty. The market is quieter than for some weeks, and transactions have not been many nor large. There is an absence of feverishness and anxiety. This condition is due partly to the fact that arrivals have been more plentiful recently. The total to May 28 for the month was 5295 tons, a generous amount, and larger than in some time. The quantity afloat was 1977 tons on the same date. In general, dullness has prevailed most of the past week. On May 23 there were a few sales of spot tin at 65.50 to 65.60c., with a few sellers at 65.25c., New York. On the same day Banca tin was sold at 63c., ex-steamer at dock. On May 24 spot Straits tin was sold at 65.40c., with offerings at 65c. Spot Banca on the same day was offered at 62.50c., New York, but there were no buyers. On May 25 the price fell off to 65c. where it still was yesterday, with the market dull and flat. Yesterday there was no business and the market was stale. The general halt in activity is largely due to conditions at Washington. The London market is still strong, the last quotation having been £253 17s. for spot Straits on Saturday, May 26, yesterday having been a holiday in England.

LEAD

The lead market is the strongest of all the metals and continues to gain in strength each week. In the past few days prices have risen steadily on moderate sales, due to a fairly large demand, but with supplies relatively small to meet this. Most of the large producers continue out of the market, because of the uncertainty as to just how much the Government is to require. Until this is settled, conditions will remain more or less as they are. High prices usually curtail consumption, but under the present abnormal or war-conditions this will prove an exception, and the effect on business will probably be of little consequence. Some Mexican lead was sold during the last week, and a fair business has been reported in it. It went at full prices in bond. It was looked upon with favor for export purposes as the price was under domestic metal because of duty-questions. One dealer reports selling a carload of domestic lead at 11.50c., New York, yesterday to a jobber. The quotation today was 11.22½c., St. Louis, or 11.37½c., New York, a slight advance over yesterday.

ZINC

The market is firm with futures higher than spot or nearby metal. This is due partly to the strong ore situation, but largely to the attitude of the large producers. As high as 9.50c., St. Louis, has been bid and taken on June-July shipment of prime Western, though ⅛c. under this is also reported for this position. The nearby market is very quiet at from ⅛ to ¼c. under the quotation for future delivery. Demand for any position is very light, though some sales are reported. The expectation is that not much activity is likely until the Government's needs are more fully known. Exports for April, as far as reported, total 9617 tons.

ANTIMONY

Demand has fallen off somewhat and the market is easier at 24 to 25c., New York, duty paid, for Chinese and Japanese grades. The demand for future delivery is reported as good, with prices firm, and at higher levels than in some time.

ALUMINUM

Some interest is taken in the personnel of the aluminum committee of the Council of National Defense. It is: Arthur V. Davis, president of the Aluminum Company of America; E. E. Allyne, president of the Aluminum Castings Co., Cleveland, Ohio; Joseph A. Janney, of Janney, Steinmetz & Co., Philadelphia. The market is unchanged at 59 to 61c. for No. 1 virgin metal, 98 to 99% pure.

ORES

Tungsten: The market has changed but little since last week. Demand is light and quotations are about the same. The official price for 60% concentrates is $20 per unit. Ferrotungsten is quiet, with the quotation at $2 to $2.15 per lb. of contained tungsten, though some are asking as high as $2.35 per pound.

Antimony and Molybdenum: These ores are unchanged from last week, and the demand is very quiet. It is stated that there is a growing recognition in this country of the value of molybdenum steel for ordnance purposes.

INDUSTRIAL PROGRESS

Torsional Strength of National Pipe

The accompanying illustration shows a piece of 8-in. National line-pipe, after being subjected to a torsional stress of 713,000 inch-pounds. The weight of 8-in. National line-pipe is about

TORSIONAL STRENGTH OF NATIONAL PIPE

29 lb. per ft., with walls approximately ½-in. thick. Material to withstand such an enormous strain, without fracture, must be of the very highest quality.

The photograph was taken to show the result of this unusual test—not merely as a curiosity, but as an evidence of progress in the manufacture of wrought pipe.

The Catalogue Numbering-System

Catalogues have become necessary in conducting all lines of business. They are issued in such profusion and in so many different sizes, that it is a difficult task to index and file them accurately for ready reference.

The most urgent need is for a universal, permanent, practical, simple, and cheap means for indexing and filing, past, present, and future catalogues. The catalogues of today are indispensable to both the buyer and the seller; they are, and should be, treated as text-books full of valuable information, and every effort should be made to encourage the maintenance of a properly conducted catalogue file.

The prevailing custom of distributing catalogues is expensive, wasteful, and inefficient because the merchant loses control of his catalogue as soon as it is dropped in the mail-box. There is a decided difference between furnishing a catalogue upon request, and its general distribution. In the first instance the party is immediately interested; in the second, he may be at some later date, therefore, in order to be of value the catalogue must be filed and properly indexed.

A concerted effort should be made to standardize the size and shape of all catalogues according to some generally accepted plan, but it will take years before this will be universally adopted. The Catalogue Numbering System* has just distributed its catalogue numbering 250,100, illustrating and describing a new method of numbering and indexing trade catalogues and loose-leaves that deserves attention. Two index-cards bearing the same serial number are sent with the catalogue, examples of numbering catalogues are given, and also several index-cards are shown. Advantages to be gained by the introduction of this system are set forth as well as the disadvantages of the present method of distribution. There are instructions for the printer, and how to order numbers.

The Catalogue Numbering System is in reality merely a central registering office, where selecting and assigning of numbers will be done upon request for a small fixed price per number. The number will be chosen according to the size, shape, thickness, and binding of the catalogue without reference to its text or subject matter. Numbers will not exceed six figures used in conjunction with the alphabet. The catalogues when filed numerically will be automatically grouped according to their general external dimensions in a uniform and orderly arrangement.

This system places the responsibility of numbering and indexing directly upon the manufacturer or merchant issuing the catalogue; it permits him to retain control of his catalogue until it is indexed and placed in the customers' files; it assures him that his catalogue will be filed, if it is not destroyed, and it will not be destroyed because it is self-filing, and also that it will be indexed according to his own dictation. Those receiving catalogues are directly benefited because they can eliminate all the trouble incident to filing.

Some prefer to file catalogues alphabetically, the only logical reason for this is to avoid indexing; others try to group them according to subject matter, which cannot be done except in certain lines of trade, because catalogues usually describe more than one article and some are volumes of general information; the only satisfactory alternative is to assemble them according to size and number them in sequence. It is too much to expect that every one is competent to index all catalogues, but there is none better able to index the one catalogue than he who writes or compiles it. This demands that the index-cards must be furnished as a part of the catalogue.

Binders for catalogues are expensive and cumbersome, their only excuse is to gather the several catalogues of one concern together in one place in the files, and in this they are unsuccessful because filers will not go to the trouble of inserting the new catalogues in the binders. When catalogues are serially numbered there is already a predetermined place for them and binders become superfluous.

As an example in the application of this system:

The merchant wishes to issue a catalogue and decides upon its size, shape, thickness, and binding; he communicates this information to the Catalogue Numbering System, with a request for the serial number which will apply to the entire issue of the particular catalogue concerned. The charge for selecting and registering this number is $1. The number is printed in the upper left-hand corner of the front cover and also on the index-cards to accompany the catalogue. Two or more index-cards are to be furnished, one having for its title the name of the issuer, and one for each subject described in the catalogue. Those receiving the catalogue file it numerically and distribute the cards alphabetically in the card-index file.

In anticipation of future issues of catalogues of approximately the same general dimensions, consecutive numbers to any extent for a given size of catalogue may be obtained at one time, thus permitting the grouping of these catalogues automatically for all time.

Catalogues on hand ready for distribution can be numbered and cards inserted; this will permit them at once to become a part of this system. If a record is kept of outgoing catalogues,

*338 Pine street, San Francisco, California.

the cards and the number can be mailed to those having them in their files.

The most important feature of this system is that it can be applied immediately to existing catalogues in the file. A circular-letter sent to the issuer requesting the cards and the numbers applying to his catalogue in your file is all that will be necessary.

What has been said about catalogues also applies to loose-leaves, (pamphlets, bulletins, price-sheets, circulars, reprints and unbound folders). With a few modifications these are taken care of in the same manner. Loose-leaves should be filed in vertical letter-filing cabinets; they should not exceed 9½ by 11¾ in. when folded ready for filing. The numbers should be printed in the centre on all four edges. Numbers will be chosen according to size and subject matter, that is, price-sheets will not be grouped with reprints or circulars.

Cost of Pumping by Gas-Engine Driven Centrifugal Pumps

The cost of pumping water is made up of two principal elements; the fixed charges consisting of interest, repairs, maintenance, and depreciation; and the cost of fuel. The fuel-cost varies inversely as the duty of the engine, but recriprocating-engines, showing the highest duties, may also be the most costly, so that what is gained on fuel consumption may be lost in interest and depreciation charges.

For example, a comparison of the 1100-hp. triple-expansion pumping-engine at the Bissels Point station, St. Louis, which upon test showed a duty of nearly 203,000,000 ft.-lb. per 1000 lb. of steam, with the 1200-hp. steam-turbine driven pump at the Kirtland station of the city of Cleveland, which showed a duty of slightly over 152,000,000 ft.-lb. per 1000 lb. of steam, developed the fact that the unit showing the lower duty was the more economical. The total cost of the reciprocating equipment, including buildings, foundations, boilers, and boiler-plant complete, was about $195,000, while for the steam-turbine driven centrifugal pump, it was about $84,000. Assuming both stations to use coal costing $1.70 per ton, the total cost of pumping with the centrifugal-pump was $23.08 per water horse-power year, of 365 days of 24 hr. each, as against $27.60 for the reciprocating-pump. Of these amounts, approximately $17.50 for the centrifugal-pump and $13.50 for the reciprocating-pump represented fuel.

In some localities natural gas of high heat value can be obtained at low cost. Taking advantage of this fact and of the superior efficiency of the gas-engine, as compared with the steam-engine, the city of Clarksburg, West Virginia, has been able to reduce the fuel-cost of pumping to about $7 per water hp. per year. The pumping equipment at Clarksburg consists of a 50-hp. gas-engine driving through speed-increasing gears a 4,000,000-gal. per day De Laval centrifugal pump, which delivers water against 35-ft. head to the filter-bed, and a 350-hp. gas-engine running at 200 r.p.m., driving through double-helical speed-increasing gears a De Laval two-stage centrifugal-pump, delivering 4,000,000 gal. per day against 350-ft. head to the city reservoir.

The gas-engine was guaranteed to deliver a brake horse-power on 10 cu. ft. per hour of gas of a heating value of 1000 B.t.u. per cu. ft. During a ten-days' continuous run the total consumption of the high-service and low-service pumps together was found to average 82,200 cu. ft. of gas per day. During this run the capacity was kept up to 4,100,000 gal. per day, the high-service pump delivering against about 330-ft. head, and the low-service pump against 30-ft. head, a total of about 258.5 water hp. The gas is received from wells nearby belonging to the city and is charged for at 6c. per 1000 cu. ft., although the commercial power-rate in that locality is about 8c. The fuel-cost of a water horse-power would be $6.96 per year at 6c. and $9.27 at 8 cents.

The complete cost of the pumping-equipment was approximately $17,500. The cost of the substructure, superstructure, crane, piping, and appurtenances complete, was $13,905, or a total of $31,405. The annual interest, depreciation, and upkeep charges upon this amount at 8% would be $2512.40 per year, or $9.71 per water horse-power, giving a total cost of pumping, exclusive of attendance and supplies, of $16.67 per water horse-power year of 365 days of 24 hr. each. For 16 hr. operation the cost would be $14.35.

Link-Belt Silent Chain Drives

The Link-Belt Company of Chicago, has issued an instructive, well illustrated pamphlet, No. 253, descriptive of its silent chain drives. It is entitled the 'Ideal Drive for Cement-Mill Equipment,' and describes, with numerous illustrations, the large Link-Belt silent chain drive installation at the plant of the Nazareth Cement Company, at Nazareth, Pennsylvania. Some of the details of the silent chain drive have already been described and illustrated in a previous issue.

The Necessities of Business Expansion

The business of the Imperial Belting Company, manufacturers of Rexall double-stitched belting, has grown to such proportions that it has become necessary to double the factory space, and the company has taken over the four-story fireproof building adjoining the present plant at Lincoln and Kinzie streets, Chicago. Most of the new machinery is on the ground and it is expected to have same in operation within the current month.

Commercial Paragraphs

VALERIUS, MCNUTT & HUGHES, petroleum geologists and engineers, have opened an office at Lexington, Kentucky, with V. H. McNutt in charge.

At a meeting of the board of directors of the WALTER A. ZELNICKER SUPPLY CO., St. Louis, held April 19, A. R. Topping was elected secretary of the company. Mr. Topping has been associated with the Zelnicker company for the past eleven years and his advancement has been rapid.

A. E. Drucker and G. W. Laurie have opened an office at 30 Church street, New York, the firm to be known as DRUCKER & LUARIE. They will specialize in mill design and construction, and will undertake the starting of mills or other plants erected for the treatment of the ores of gold, silver, copper, lead, and zinc.

O. H. Johnson, who has had charge of the Marcy mill department of the MINE & SMELTER SUPPLY CO., in Salt Lake City, together with his staff, has moved to Denver where they will make headquarters in connection with the general offices of the company. The move was made for the purpose of giving better service to the users of Marcy mills and also to the branch houses of the Mine & Smelter Supply Co. in their efforts to sell and market the machine.

E. I. DU PONT DE NEMOURS & CO. has issued several timely and valuable pamphlets on the various powders made by that firm—powders for blasting, for sporting-ammunition, for ordnance, and for every other purpose for which explosive agents of any kind or grade are required. These books contain a vast amount of valuable and practical data on the manufacture, the storage, and use of powder, the rules for safety, for thawing, and many other interesting things. The users of nitro and other powders may obtain copies of these books on application to the company or its agents.

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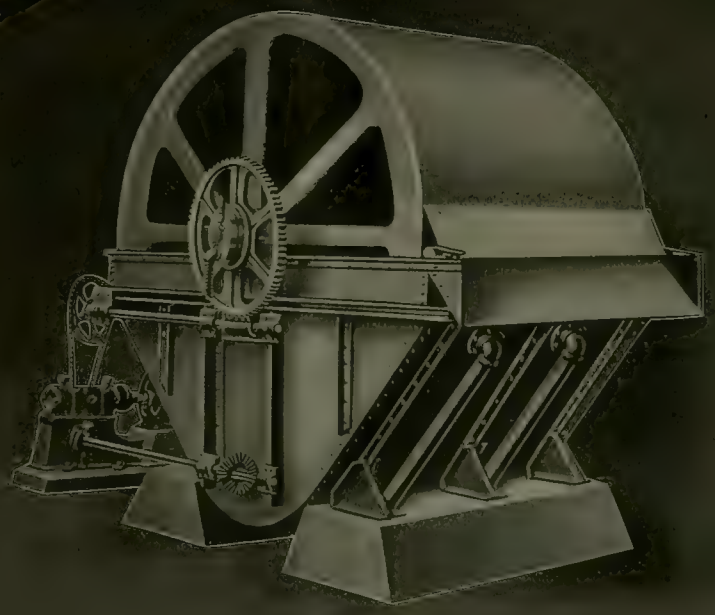

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W. H. STORMS - News Editor

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C. T. HUTCHINSON, Manager
E. H. LESLIE
600 Fisher Bldg., Chicago
A. S. BREAKEY
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Science has no enemy save the ignorant

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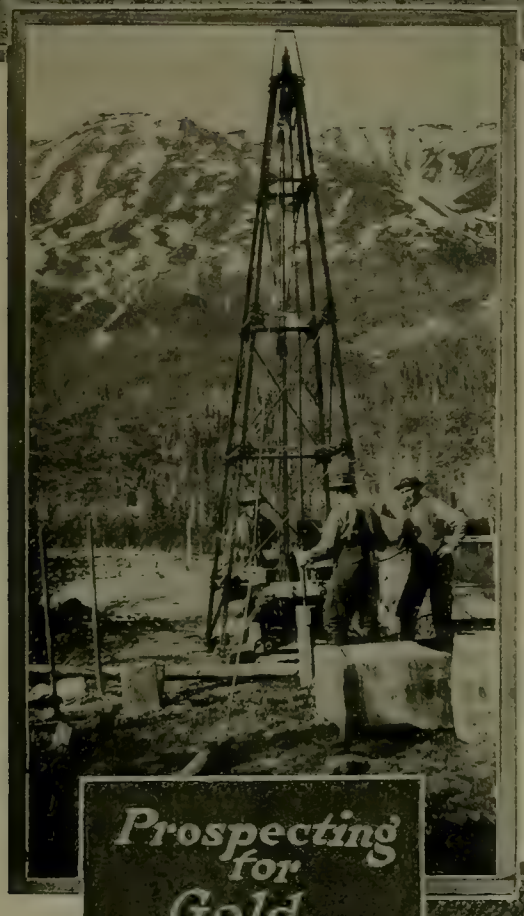

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EDITORIAL

T. A. RICKARD, Editor

IT IS high time to cease speaking of *the* Allies and *the* War in Europe; it is *our* Allies that are fighting splendidly for a cause to which we are now committed and to which we are already contributing greatly. Unless we make it *our* War it will be *our* defeat, a word not yet in the lexicon of American democracy.

DETERMINATION of lead by a volumetric chromate method is discussed in this issue by Dr. John Waddell of the School of Mining of Queens University, Canada. The method was proposed some years ago by Mr. H. A. Guess, but the elaboration of the details by Dr. Waddell has increased its accuracy so as to give it marked advantages, especially for low-grade samples, over the molybdate method.

OUR allies need 1,400,000,000 pounds of copper this year, we are told; while our Government will require 250,000,000 pounds, with another 100,000,000 required early next year. The production of copper in the United States is now at the rate of 1,800,000,000 pounds per annum, so that more than an adequate market seems assured, since provision must be made also for our ordinary domestic consumption, which is increasing.

A MINING ENGINEER from Colorado called upon Mr. John Ballot, chairman of the Minerals Separation company, in London, to obtain a license to use the froth-agitation process. When he was told that the plant was to have a capacity of only 100 tons daily, Mr. Ballot refused to grant a license or to bother about the business. That shows the spirit of these patent-exploiters. Are they to have the right not only to issue permits but to refuse a permit at will?

MEXICAN stocks are strong on the New York exchange, owing to quieter conditions in Mexico and the resumption of operations by the American Smelting & Refining Company. At El Paso the opinion is not so optimistic. The leopard can only change his spots by being compelled to move. No loan to the Mexican government is to be made either by our Government or by our banks. Carranza is flirting with the Germans and Obregon is touring the country with German officers in uniform. We know how much to trust the shifty gentleman on the other side of the Rio Grande.

IN our issue of April 7 we discussed mining by the State, with particular reference to the Transvaal, where this socialistic idea was then under serious consideration. On April 21 the majority report of the South African State Mining Commission was published at Johannesburg. Three members of the Commission voted against the proposal and joined in advising the Government that it should not engage directly in the mining of any minerals; the two other members wrote separate reports expressing their divergent opinions. Both, however, advocate State control of the mining and marketing of diamonds. The mining industry of the Rand is to be congratulated on the exorcising of this bogey.

OUR New York contemporary has been misled by irresponsible newspaper chatter into writing some cheap stuff against Congress, five times repeating the silly slogan, "The people want you to come home." The writer of such balderdash ought to know that under a system of representative government it is customary and necessary for the national legislature to ventilate opinions and to give public expression to the ideas of a democratic community. The Administration has done well, but it would be a gross political blunder to send Congress home with the idea of leaving the President and his cabinet uncontrolled by such public opinion as the legislative authority is authorized to express. There has been a good deal of talk in Congress, and some of it may seem unnecessary, but the volume of speech has not been out of proportion to the importance of the matters discussed. The idea of treating Congress as if it were a wearisome superfluity is undemocratic and it is childish.

METAL MINES rarely experience calamities so costly in human life as the conflagration in the Speculator mine of the North Butte Mining Company, where more than 60 men are known to have perished on Saturday last. It is feared that the death-roll may swell to 150. The helmet-men of the mines-rescue organization did splendid service, but in the lower workings, on the 2200-ft. level, they found gases so dense as to render their equipment inadequate, thus seriously limiting their effort at relief. As often happens, the crisis developed a hero, a tool-boy, Manus Duggan, who will have honor in the annals of Butte. The fire is said to have been caused by the ignition of frayed cable-insulation by the heat from the flame of a carbide-lamp. The shaft-timbering intensified the difficulties, and points to the need of employing concrete or metal framing in working-shafts of such importance. Two men were caught in the cage above the flames, unable to signal because the wires attached to the timbers had been destroyed; and the shaft presently began to cave as the supports burned away.

Whether blame may be directly attributable to anyone we do not know, but lessons will be learned from the disaster that must lead to safeguards for the future.

AT the annual meeting of the Institution of Mining and Metallurgy, it was voted, unanimously, to send the following telegram to the American Institute of Mining Engineers: "The Institution of Mining and Metallurgy, assembled in London in annual general meeting, sends fraternal greetings to the American Institute of Mining Engineers, and rejoices in the new bond of friendship and unity of purpose between the two societies resulting from the great historic act of participation of the American people in the war of freedom and civilization against military autocracy and barbarity." The prompt reply was as follows: "Your cordial greetings much appreciated by American Institute of Mining Engineers, whose board of directors at its meeting last evening responded with sincere wishes and statements that the members of our body are doing all in their power to hasten active participation with our Allies. (Signed) Philip N. Moore, President; Bradley Stoughton, Secretary." The mining engineer may be a good deal of a cosmopolitan, but his cosmopolitanism is of a selective kind, and in this crisis of civilization he has no trouble in deciding how to align himself. In mining, as in sport, and in sundry other matters even more important, we Americans are glad to stand shoulder to shoulder with the British and French. Out of evil may come good, and one of the chief blessings of the War is this comradeship between the democracies.

MINERALS SEPARATION has collected $1,115,500 in royalties during the last two years, so says the *Boston News Bureau*. The first American company to take out a license was the Inspiration, in April 1913. By the way, we can state that the Inspiration-Anaconda contract does not run indefinitely; it expires with patent 835,120, namely, on November 6, 1923. On that date the two copper companies regain freedom of action. The other licensees are said to be the Consolidated Arizona Smelting Co.; Atlas Mining & Milling Co., Elm Orlu Mining Co., Old Dominion Co., Mountain Copper Co., Weedon Mining Co., St. Joseph Lead Co., Cananea Consolidated Copper Co., Arizona Copper Co., Doe Run Lead Co., Utah Leasing Co., Colusa Parrot Mining & Smelting Co., Goldfield Consolidated Mines Co., Ducktown Sulphur, Copper & Iron Co., Britannia Mining & Smelting Co., Mond Nickel Co., Cuba Copper Co., Standard Silver-Lead Co., Braden Copper Co., and Phelps, Dodge & Co. At least one of these has refused to sign a contract and others have tied themselves not too firmly. The Minerals Separation people assert that 35,000 tons of ore is treated daily by those they call infringers, meaning non-licensed operators. This is equivalent to 12,500,000 tons per annum, and it is a conservative estimate, for everybody that uses flotation does not notify either Dr. Gregory or Mr. Nutter. If 15,000,000 tons is treated by non-licensed operators this year, the royalty, at 10 cents, would be $1,500,000; but even that does not measure the tribute to be exacted. The group of copper mines under Mr. Jackling's management will produce 600,000,000 tons in the next 30 years; at 10 cents that means $60,000,000. The stake involved is big enough. Next, consider the oil consumed; if that absurd 'critical' proportion is to be the limit of the Minerals Separation embargo and 20 pounds more is to be consumed to prove that the Supreme Court was deceived, then in 1917 we shall require something like a million barrels of oil for use in the flotation mills of this country. The amount of oil consumed annually would generate 46,000 horsepower continuously and the production of it would entail the destruction of 800,000 cords of Southern pine. These are figures big enough to emphasize the fact that the claims of Minerals Separation trespass seriously on our national resources.

Colorado School of Mines

This technical institution has been the unfortunate victim of a fiasco that is not without its wider bearing on the education of young men in other States. We have taken pains to ascertain the facts, hoping that our unbiased comment may interest the alumni of the school and also the profession at large. On April 23, which was Senior Day, the customary fun was carried too far. Several seniors and many sophomores were drunk by the time the base-ball game was begun. A member of the faculty was 'wrinkled,' which is a form of hazing particularly repulsive to a man with any self-respect. The students were more unruly than usual, the police-court verdict of 'drunk and disorderly' being adequately descriptive. At the subsequent meeting of the faculty it was decided to suspend five students for one year and to reprimand others. When the suspensions were announced the student body protested and later decided that "the three lower classes would quit school as individuals." The seniors wished to follow suit, but it was decided that it would be a serious mistake for them to miss graduation. The president of the School, Mr. H. C. Parmelee, addressed a meeting of the students. He showed commendable firmness. Mr. Parmelee had been a trustee before being appointed—a year ago—to the presidency of the School. For both positions he was endorsed heartily by the Colorado Scientific Society, and he is receiving the cordial support of the mining profession in Colorado, more particularly the alumni of the School. A committee of the students met the board of trustees, who then recommended the faculty to re-consider the case. A committee of local citizens—at Golden, where the School is established—interfered and called upon the Governor of the State to take a hand. He sent a trustee that he had appointed eight months previously, Mr. A. E. Carlton, who had not attended a board meeting up to that time. Mr. Carlton assumed an intelligent attitude, but immediately thereafter he resigned. Matters drifted. The students returned to their homes. At the commencement, on May 25, only the graduating seniors were pres-

ent, besides the alumni and general public. Last term the School included 175 students, of whom 30 were seniors. Its governance is in the hands of five trustees. Here is where the trouble begins. The trustees are not elected; they are appointed by the Governor. One of them is a reporter on a Denver paper, a man as unfit to direct the administration of an educational institution as he would be to direct an astronomical observatory; another trustee is a small banker at Golden, also without special qualification, but, of course, extremely anxious that the attendance at the School shall be maintained unimpaired for the benefit of the local boarding-houses and trades-people; the third is a banker and financier, already mentioned, one of the big men of Colorado, a clever and energetic man, but so immersed in his own affairs that he has no time to attend to his duties as a trustee, an appointment he should never have accepted; the two other trustees are unexceptionable, both being graduates of the School and mining engineers of excellent reputation, Messrs. O. R. Whitaker and F. W. Willis. In short, the board of trustees contains two that are fit for their duties and three that are unfit. That is sufficient reason for the chaos. Another is the manner in which the local press treated the affair. Denver, like San Francisco, suffers from its miserable newspapers. The *Post*, like our *Examiner* and *Chronicle*, is mean, malicious, and misinforming. The *News* is feebly respectable, but even this less vicious paper injured the Colorado School of Mines by the piffle that it has published during the past month. Another factor is the laxity of discipline at Golden. To the students the action of the faculty, in suspending the five students, seemed severe because they were unaccustomed to proper control. They had the cheek to say that they would return "when the faculty would promise to work in harmony" with them. This reminds us of the telegram sent by a State Senator to the Governor of Colorado when, in 1903, the strikers had driven the Smuggler-Union miners, by the free use of bullets, out of the Bullion workings. The sapient legislator reported to the Governor: "The strikers are now in peaceful possession of the mine." So now the students ask for a faculty that will continue in peaceful subservience to them. What they need is military discipline. Disloyal to their alma mater, which they have brought into ridicule, mutinous to their teachers, reckless of their careers, how can they expect to become fit to direct the work of other men in mines and mills if they themselves exhibit so little self-control? We hope that the president and faculty will not make the egregious blunder of giving way in this crisis by allowing the students to return at will. They should be required individually either to make an apology or to express regret for their conduct. If not, the tradition of unruliness will be perpetuated and the seed of future trouble will be re-sown in the School.

The Colorado School of Mines is 43 years of age. It has had a chequered career, owing to lapses in administration, but it has furnished the American mining industry with a large number of capable men. It ranks with the Michigan College of Mines as a technical institution, lacking academic distinction it may be, but effective in training engineers and metallurgists of a forceful kind. The School has performed the work for which it was created and deserves to be supported both by the State and by the mining profession. The annual appropriation is $95,000. That does not seem too much. Nevertheless there has been talk of tacking the School to the State University at Boulder, so as to end the frictions and fusses that have disfigured its record. Whether that step is advisable, we do not know; it is one that should not be taken without asking the opinion of the alumni, in the first place, and of the mining profession in Colorado. We urge the local section of the American Institute of Mining Engineers at Denver to take an interest in the matter and to do its best, collectively and individually, to support the School, so that it may continue to be a seat of education, social as well as scientific, in the great mining region of Colorado.

Sulphur and the Food Supply

The article contributed to this issue by Dr. P. J. O'Gara, the director of the agricultural experiment station maintained by the American Smelting & Refining Company near Salt Lake, Utah, is a message full of significance for the nation at this period of stress. We must feed England and France as well as our own people; we must feed an army that will grow from month to month until it will number millions of men; we must feed an increasing horde of workers in the factories. It is estimated that this industrial army alone will need to be augmented more than 25% within the coming year in order to provide the multitudinous supplies that will be required in the conduct of the War. Although women will supply the call for labor to some extent, the fact remains that there will be fewer men available to produce the food that is essential for sustaining the nations warring to preserve the institutions of liberty. The call from Washington to make every lawn into a garden, to turn every boy into a producer of potatoes and beans and corn, is prompted by a clear vision of the insufficiency of farm products that we are facing. We must have enough food to supply our vital forces or we shall weaken, and that means disaster.

The lesson that Dr. O'Gara teaches is that sulphur will make one man more than the equal of two in the raising of wheat, and the equal of four in the raising of peas, to name no other crops. It appears that elemental sulphur used as a fertilizer, at the rate of from 300 to 400 pounds per acre, is an energetic stimulant to nearly every variety of crop. As compared with untreated lands the increase of yield is from 63% for potatoes to 383% for peas. The grains are all strongly responsive to the influence of sulphur, especially on soils that represent the decomposition-products of granitic rocks, but the most amazing effects are produced with the leguminous plants. Dr. F. C. Reimer, of the Southern Oregon Experiment Station, has shown that

the cut of alfalfa can be increased in some cases as much as 500% by harrowing 300 pounds of raw sulphur into each acre. Equivalent improvement is obtained with beans and other legumes. To achieve such results is like multiplying the land, and is even more than multiplying the tillers of the soil, for it represents an increase in production without more mouths to feed. The American Smelting & Refining Company has done a great service in applying the methods of the trained technologist to demonstrate that the smelter not only should live as the harmonious contributor to the welfare of his agricultural neighbors, but that the farmer needs him as a resource for the sulphur and sulphuric acid with which to improve his soils and increase his net returns. We pointed out a few weeks ago the splendid work of Dr. C. B. Lipman, of the California Experiment Station, in reclaiming alkali lands by the use of sulphuric acid. This in itself showed that the old feud between smelter and farmer was coming to an end. The employment of elemental sulphur, however, extends the possibilities for both. Sulphur has a wider range of usefulness; it is adapted to soils to which the addition of acid would be undesirable; it is suited to the conditions of Georgia, or Virginia, or New Jersey, as well as to the alkali lands of the Salt Lake basin or the San Joaquin valley. It may be said that the one important limitation upon the adaptability of sulphur is that it may produce acid soils unless sufficient lime be present. The use of lime and sulphur together is indicated where there is a tendency to sourness. Gypsum is also a stimulant to the bacteria that promote the nitrification of soils, so necessary to the active growth of beans, peas, clover, and alfalfa; and it also shares with lime, to some extent, the function of flocculating or 'loosening' loams that are heavy with clay. The presence of abundant lime is necessary to provide base for the excess of acid formed in the process of bacterial nitrification, which otherwise would stop. Also, an excess of base must be present to take care of the sulphuric acid produced by the bacterial oxidation of the sulphur, in order to yield the neutral sulphates, in which form only the plant can take the sulphur into its circulation. All this suggests possibilities of utilizing readily available raw resources of sulphur and gypsum to increase our food-production immediately, without waiting for the smelters to get ready to turn out elemental sulphur and sulphuric acid in quantities adequate for yielding the prompt results that the nation demands.

It is desirable, before approaching that side of the subject, to call attention to a fact that had been overlooked until recently concerning the needs of plants. Determinations of the sulphur in their composition had been based upon analyses of the ash, which showed insignificant quantities of that element. It was then discovered that sulphur was present in surprising amount in the form of volatile organic compounds, and perfected methods of analysis have now demonstrated that sulphur enters into the composition of many plants of high economic value in even greater proportion than phosphorus, potash, or nitrogen. The story of Dr. Reimer's investigations, following a method of elimination which finally proved that it was the sulphur that gave the stimulant needed by some of our most useful crops, possesses the quality of romance. He found that alfalfa holds in its tissues seven pounds of sulphur per ton of dried cut, while it contains only five pounds of phosphorus. Rape is still more remarkable, secreting in its tissues 20 pounds of elemental sulphur per ton. All plants require sulphur in some proportion, and even where the amount absorbed is not large, as in the case of cereals, the gradual formation of sulphuric acid, by oxidation of the sulphur, accompanied by the liberation of hydrochloric acid from the chlorides present, causes decomposition of the silicates with the ultimate production of sulphates of the alkalis. Thus the potash in feldspathic particles, which are particularly abundant in soils derived from granites and in the great areas of residual soils covering the pre-Cambrian rocks that stretch along the Atlantic coast from Pennsylvania to Georgia, is liberated in soluble form as a result of adding sulphur.

The agricultural experimenters possess the progressive qualities and also the conservative limitations that are characteristic of highly trained research-technologists. They have demonstrated the possibilities of utilizing sulphuric acid and elemental sulphur to cure the defects of excessive alkali, and to stimulate productivity to a degree that seems marvelous. They have done more than merely to show how to turn smelter-fume from a cause of litigation into the greatest boon the Western farmer has been offered, next to the waters for irrigation. They have revealed how suddenly to multiply many-fold the food-resources of America. With the modesty characteristic of accomplished scientists they hesitate to insist upon energetic action until their field-tests shall have repeatedly confirmed in every detail the results obtained; but the country needs to utilize what they have discovered and to do it now. These men have shown that plants need sulphur; that to supply it increases their growth at an enormous rate; they have shown that the sulphur promotes the nitrification of soils when sufficient alkaline sulphates are present; they have demonstrated that the readiest solution of the potash problem in its more acute phases is to add sulphur, which results in releasing the potash in a form requisite for plant assimilation, while the sulphur supplied gives the lusty deep green significant of a healthy and vigorous growth. We have found lately a great potential resource of potash in the cement and iron-furnace plants of the country. This can be rendered available more quickly under a military mobilization of our resources than would be possible through the partial re-construction and elaborate additions necessary for recovering elemental sulphur and sulphuric acid from our great copper-smelting plants. In a year or eighteen months they might be yielding large amounts. Meanwhile sulphur is immediately available from natural deposits, close to transportation conveniences, in several western States. At Thermopolis and Cody in Wyoming it has been found in limestone, associated with travertine and gypsum, and can be excavated in open quarries. In

the San Rafael canyon in Utah is another deposit of similar type, having a greater preponderance of gypsum. In El Paso county, Texas, near Guadalupe and Toyah, is an area nearly 50 miles in length and over 15 miles in width where gypsum beds impregnated with sulphur to the extent of from 10 to 20% occur in multitudinous outcrops, and where many large areas exist from which sulphur-bearing gypsum three to four feet thick can be obtained by removing less than three feet of overburden. In the same district are earthy deposits, containing more than 50% of gypsum, and 25% of sulphur, that have been explored to depths of 40 feet. Feeble efforts have been made to extract sulphur from all these deposits, but the great opportunity that they offer is that of pulverizing and shipping the material as it is for direct application to soils in order to increase the yield to meet the demands of the present crisis. The contained gypsum and lime would be helpful, as we have shown, in promoting conditions favorable to the increased growth of plants. What would be the effect of a single million tons of the crushed rock with 15% sulphur? It would amount to 20,000 carloads, which, incorporated into wheat-lands in the autumn, would add apparently more than 15 million bushels to next year's crop. It would increase the crop of beans from a million acres by 2,000,000,000 pounds; it would multiply the output of peas from that area by 5,000,000,000 pounds. Is it not worth trying? We shall soon expend more money that this would involve in the mere testing of new devices for warfare. It may not do all that we hope, but intelligently directed it can be counted upon to more than double the yield of the acreage that can be reached with the sulpho-gypseous output from the sources mentioned. A militarized nation will not hesitate; it will commandeer the men who know how to find and distribute and utilize these natural resources of combined sulphur and gypsum to help in feeding the men that are fighting for our country. Thus one part of the problem of providing sulphur, fixed nitrogen, and soluble potash, can be solved without delay. It can be made to affect some of the late crops of the present year. Meanwhile the Government could take a hand with the American Smelting & Refining Company and other smelters to insure that a sufficient output of by-product sulphur for agricultural purposes will be provided for the future.

Millions in Bubbles

This is the title of an article in the *Boston News Bureau* and it serves to emphasize the importance of the flotation litigation; but to our mind even more than millions of dollars is involved: nothing less than the self-respect of an industry. The question is whether the mine-operators of America are to be domineered by an exacting monopoly and whether the profession is to pay not tribute but subservience to a group of patent-exploiters. As our readers know, we do not believe that Minerals Separation either invented the process of flotation or developed it to its present state of efficiency. They contributed to both, and they are entitled to some credit for both, but not to the extent of holding up the mining industry or of tying the metallurgical profession to their chariot-wheels. We note that our Boston contemporary assumes that the Miami company must pay $4,000,000 and the Butte & Superior $18,000,000 in damages to Messrs. Ballot, Gregory, et al. Not yet. The representatives of Minerals Separation in San Francisco have celebrated their latest legal victory in proper gastronomical fashion, accompanied by bubbles of carbon-dioxide in an amber vintage, but we believe the celebration to be premature. We hope so. The gentlemen of the Miami company are by no means depressed, for they believe that the Philadelphia decision is no final legalization of royalty-hunting. Mr. Nutter may exclaim that he is after blood, of a yellow color, referring to standard currency and not the veins of our friends, and Mr. Ballot may clench his fist and swear that he is going to bring the so-called infringers to his feet, but the end is not yet. The new suit recently begun at Butte will re-open the whole litigation and in the new record there will be written much evidence of a decisive kind that did not exist when the Hyde and Miami suits were heard in the courts of first trial. Truth will prevail, if the leaders of the industry are not stampeded into a compromise. The Supreme Court may have been hocus-pocused into the idea that a 'critical' proportion of oil is necessary for flotation as now carried out, but the operation of 1000-ton mill-units has proved that the idea of a critical factor below 1% is mythical. In the same way the fallacy of measuring the oil in ratio to the 'ore' has been swept into the limbo of absurdities, for it is known and demonstrable that the proportion of oil is determined by the amount of work it has to perform, which is dependent directly upon the weight of mineral, usually sulphide, in the pulp, and after that upon the degree of dilution and aeration. Indeed, before the litigation is done, it is more than probable that oil, as such, will not be used, because other agents for the purpose of froth-making will have come into practical service. The fact is that the Minerals Separation people, who stumbled upon a valuable idea in consequence of the work done by others in the Central mill at Broken Hill long before the pseudo-miraculous discovery said to have been made in London in March 1905, had rudimentary and incorrect ideas of the principles underlying the process when they set out to collect toll from the mine-operators. Since then great improvements have been made by others, and it is to these improvements, in machinery and manipulation, particularly the latter, that the process owes the greater part of its success. The credit that belongs properly to Minerals Separation has been discounted by their arrogance and greed; it is our earnest hope that they may be prevented from placing a tax on the industry as they have failed ignominiously in placing an embargo on technical information. In this issue we reproduce the majority opinion of the Circuit Court of Appeals in the Miami case; next week we shall give our readers the text of the dissenting opinion.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Home Vegetables

The Editor:

Sir—It has come to my attention that certain of the mining companies throughout the United States have officially taken up for their employees, the wives of employees, and children, plans for the growing of vegetables in the yards of the workers and even on vacant land owned by the companies. Some of the companies have even gone to the extent of supplying, either free or at cost, fertilizer and seeds, and also made provision for the plowing of the ground at actual cost. In other instances the companies have offered prizes for the best gardens of $25 for the first; $15 for the second; $10 for the third, and a number of minor prizes, with the result that a great amount of patriotic enthusiasm has been aroused.

I have been so impressed with the starting of such a movement, modest as it is at the present, that I feel it to be my patriotic duty to urge upon all mining companies, where the conditions are favorable, to start some similar plan that would in the end result in a vast increase in the amount of food products raised during this time of national emergency.

War today is as much a matter of food supplies as actual fighting in the trenches. The man or woman or child who raises enough vegetables this summer in his garden to feed the family places at the disposal of the men at the front fighting for a world democracy just that much food.

The growing of these vegetables has also the additional virtue of giving healthful outdoor exercise to the people and for their consumption vegetables which are fresh. Back of all this you are helping to maintain the soldiers and the less fortunate populations of the world that have been thrown out of their natural orderly life by the encroachment of the war upon their properties.

The Department of Agriculture is enthusiastically in favor of this movement and has prepared for the use of those interested Farmers' Bulletin 255, 'The Home Vegetable Garden,' which will be sent to anyone who makes application. This pamphlet has already proved of valuable assistance to those engaged in making a garden. I take pleasure in sending to you under separate cover a copy of the pamphlet, to that you may see its value in this work.

It is suggested that those who join this garden movement shall place in their gardens an American flag as a reminder that he who serves his country in this capacity serves the flag. Secretary of the Interior,

Washington, May 31. FRANKLIN K. LANE.

W. A. Farish

The Editor:

Sir—In a recent issue of your paper, I note with regret the death of W. A. Farish, on the 4th inst., at Los Angeles. Fifty years ago and more, I knew him well, he being then manager for Ferdinand Reis, the owner of Sierra Buttes mine at Sierra City, Sierra county, and not Plumas, as stated in the obituary. This mine was noted for its pockets, four of which were struck in my time, but all by chance. One yielded $15,000, another $20,000, and two $60,000 each, one of the latter being the Monumental, which furnished the big nugget you mention, and which weighed 106 lb. All of these four pockets were emptied almost at the surface, and at the slightest possible expense, but doubtless many more would have shown up, were it not for the dense growth of manzanita, chaparral, and wild plum bushes which cross the ground. It was only as a very young man that I ever knew Mr. Farish, yet I cannot but think that to his associates of later years he was the same 'Billy' Farish as to his friends of long ago.

San Diego, May 26. W. W. PHILLIPS.

Interview With Henry C. Perkins

The Editor:

Sir—While ordinarily not interested in the interviews appearing in the MINING AND SCIENTIFIC PRESS from time to time, on account of the narrow limits within which the discussions are confined, subordinating, as it were, the principles by which progress is to be made to individual accomplishment in the past, I cannot but feel that Henry C. Perkins, in your issue of May 19, has touched on phases of development that should at the present time, and must in the future, enter more fully into the business of conducting enterprises of magnitude. His brief analysis of the relative latent abilities of different races and peoples under similar circumstances and with the same facilities for development are so apt, so true, and so unerringly stated that they must be apparent to all unprejudiced minds. One-half of the world is now at death-grip with the other half for no other reason than that a 'superman,' begotten by the false ideals of one, was sought to be foisted on the other. Now, if the superman is a false ideal for mankind in general it must, von Bernhardi *et al.* to the contrary notwithstanding, be false as between nations and individuals. I can unhesitatingly say this is the case with Mexico, but as long as the white man continues to sow the wind by his injustice, dishonesty, and overbearing, he will con-

tinue to reap the whirlwind in dissatisfaction, disloyalty, revolution, and crime. When the common good, as between those that employ and those that are employed, ceases to be a factor in a business management, that enterprise is drifting dangerously near to destruction. The fatal day, by fortune or the strong hand, may be warded off for a time, but each one has seen, among undertakings that have come under his individual observation, that the law of compensation holds as inexorably in the realm of business as in the realm of philosophy. Technical publications can do more to teach this basic truth than any other medium, because it will be accepted from them, not as an evanescent dream, but as the foundation of progress, of business, and, last but not least, of profit.

Douglas, Arizona, May 24. J. H.

Crowder-Elmore—Flotation

The Editor:

Sir—In your issue of February 24 you publish under the above heading a letter of Mr. H. D. Crowder which requires certain explanations and corrections I am able to furnish; but before giving these I must protest against the manner in which you have treated certain conflicts between the statements of Mr. Crowder and facts given in my historical note of the flotation process published by you on September 23. Not only have you constituted yourself a judge in the case, which might have been expected perhaps as natural in a journalist, but you have taken on the duties of jury and executioner as well, and have pilloried both my brother and myself in a most unjustifiable manner; and you have been more hasty and inaccurate in the statement of evidence and drawing of conclusions than is allowable in a scientific journalist.

With all that has been written about the development of the 'flotation process,' and even going no further than my own historical note, it is incredible that such muddle-headed argument should still be coming up as in your article and Mr. Crowder's letter about the actual invention of that process. All the world should know by now that several inventors, at various dates, and quite independently, worked at it. Mr. Crowder senior says of Mr. Robson: "By accident he picked up a can of oil, and as he said, almost absent-mindedly tried to concentrate some of the ore. This is the true genesis of the oil process." Exactly how he tried is set forth in his patent specification, and in descriptions of his attempts by others, and is described in my historical note. Mr. Crowder states that he wrote to me in July 1899 (a year after the date of my brother's patent) giving hints on how oil might be tried; and one way was the "introduction of oil into the launder feeding the vanner" to "wet the float and carry it to a definite division." Well, Messrs. Stewart, Morris, & Richardson took out a patent in Australia in August 1895, one element of which was dropping oil into a tailing-launder below amalgamated plates, and providing the launder at its lower end "with an adjustable thin steel plate to allow the tailing to pass beneath it, while the greasy water and oil will pass above it." That looks very like an anticipation of Mr. Crowder's idea of wetting the float and carrying it to a definite division; but it does not prove robbery on his part. There is also no evidence that Robson got his oil can absent-mindedly from Carrie Everson's pudding-dish; or that Frank Elmore filched his success from Robson's experimental machine, which I repeat he never saw.

To understand some of the statements in Mr. Crowder's letter, and to refute your hasty conclusion therefrom, it is necessary to give certain facts. It is open to you as controlling a printing-press, to say with the celebrated detective, "I prefer my deductions to your facts;" but in your past kaleidoscopic presentation from time to time of the broken fragments of flotation history, you have at least shown your readers all the bits you happened to come across, so I ask you to add the following:

When my father purchased the Glasdir mine in 1896 he did so in association with a Mr. Hurst, an engineer of mining experience which was not then in the line of any members of my family; so the early operations and equipment of the property naturally depended on Mr. Hurst's judgment. The letters of Mr. Crowder senior show clearly that he failed to interest either my father or myself in his past oil experiments and he was requested to remove his small experimental machine, while steps were at once taken to erect concentration machinery.

The small experimental Robson mixer, with pump for driving oil through the thickened mass, was, while the mine was in our possession, never run; and although it was seen by me, it was quite ignored after possession of the property was taken, and it and its accessories had disappeared entirely before my brother, Frank Elmore, went to the mine as described in my previous communications. My brother had been fully occupied in certain electro-metallurgical works until he went to the Glasdir mine to examine the operation of the concentration plant more particularly. It is simply ridiculous to build up any argument from the circumstances to the effect that Frank Elmore obtained any help from the work of Robson, and that such help he and I have "disingenuously" denied. In the discussion of Rolker's paper before the Institution of Mining & Metallurgy in 1900 (after we had learnt something of history and practice in the use of oil) I gave Robson full credit for his prior work, and in my historical note, that same prior work is correctly set out; but as far as Frank Elmore in 1898 is concerned, the manner of his starting to experiment, and the results of his work, are precisely as set forth in my explanation in your issue of November 18, 1916, on page 726, ending with the words "as a matter of fact Frank Elmore has not at any time ever seen a Robson & Crowder machine." Even if he had seen the experimental machine, it would not alter the fact that he was induced to start on oil himself by the special observation referred to in my historical note; while the only important fact remains that his experiments, however started, led him in a diametrically opposite direction to Robson, and in consequence, to the development of the first practical working process.

It is inexcusable today for you to write "Mr. Crowder's letter of 1901 * * * affords a pathetic commentory on Mr. Stanley Elmore's insistent claim for originality in the use of oil for concentration by his brother and himself." My historical note is itself sufficient condemnation of such a mis-statement. There has been full publicity given to the earlier work of Carrie Everson and others and I personally arranged a pretty extensive distribution of the article by Walter McDermott in the *Engineering & Mining Journal* of New York on February 14 and February 21, 1903, beginning with the following words:

"The selective action of oil and grease on certain minerals has been made known by a number of independent investigators for some years, and several attempts have been made to utilize this knowledge for the purpose of a commercial separation of valuable products."

After describing the "greased tables" used for catching diamonds at the De Beers mine, the article continues:

"The attempt to use a thin oil for separating metallic sulphides from waste rock was made in England; and a certain measure of success was attained, in small experiments by causing the oil to pass through a moistened mass of ore. It was found that the oil used had very little supporting power; that it attached itself to the gangue to such an extent as to cause excessive loss; and the details of an effective separation of the sulphides from the supporting oil were not worked out."

Then the article proceeds to describe Frank Elmore's work.

In the case of the litigation between the Ore Concentration Co. and the Minerals Separation Syndicate, the grounds of our action were not that my brother and I were the inventors of the use of oil in concentration, but that the three men who formed the syndicate had with their engineers, worked in our testing-mill for nearly a year under a written legal obligation not to compete in any oil-concentration process; and that their various patents later acquired or taken out, were anticipated by us both by patents and by work done in the testing-mill.

Your broad conclusion that given the flotative effect of oil, results today are only due to skilful manipulation, would apply to all new processes, and all patentable improvements which rest on industrial application of given natural laws. As a philosophical summary by omniscient journalism it can be gratefully accepted, and it gives me that feeling of envy expressed by a famous statesman to a very cocksure individual: "If I could only be as sure of any one thing as you are of everything, I should be happy."

I may say in conclusion that you are in error in referring to my father as "the late William Elmore." Your suggestion of his death is like some of your other statements "grossly exaggerated."

A. Stanley Elmore.

London, April 11.

[We are glad to give Mr. Elmore space for his rejoinder. The cocksure individual to whom he refers was Thomas Babington Macaulay.—Editor.]

Grinding Plants Yielding Essential Oils for Flotation

The Editor:

Sir—For more than a year I have been endeavoring to solve the problem of economically separating galena from barite and fluorspar. The property producing the ore tested is about 35 miles from the railroad, and while water is plentiful the attitude of the owners of water rights was such as to limit efforts to handle a large tonnage. To this end experiments were made on dry-crushing and screening, and then hand-jigging (wet) after the manner of the Missouri lead-pocket miners. The tailing proved sufficiently high to warrant further investigation and flotation was tried. A small cell, modelled along the lines of the Callow type, was built. The sides were made of glass for the purpose of studying the action of the air, ore, and other minerals. Power was obtained by harnessing up the rear wheel of a Ford auto and air was supplied by attaching and adjusting the small power-pump used for inflating the auto-tires. A variety of oils was tried. With this rough outfit a saving was effected of 80 to 94% of the lead-content of an ore that averaged 10%. The scheme suggested a small plant that could be carried in an auto and used for prospecting. The plan is feasible and such a plant capable of handling about 300 to 400 lb. of ore per hour can conveniently be placed on an ordinary Ford car.

Independently of this rather comic mill on wheels, investigations were made on the utilization of desert-plant life as a means of supplying oils for flotation. Later an inquiry was addressed to the U. S. Bureau of Mines and D. A. Lyon, metallurgist, wrote, "we have tested samples of oils furnished by Maxwell Adams, of the University of Nevada. As a result we found that sage-brush oil gave splendid results. A small amount, less than $\frac{1}{5}$ lb. per ton of ore, gave clean concentrate and good extraction, when used with different kinds of ores. It proved especially good on the flotation of carbonates of copper which had received a film of sulphide by reaction with soluble sulphides. * * * Prof. Adams did not inform us as to how expensive a device would be required for the extraction of these oils from desert brush; however, we are of the opinion that such extraction will require considerable apparatus, as the oil used was refined and not the crude product which would be obtained by simple distillation of the wood." It then occurred to me that in the utilization of desert-plants and brush for flotation the plants could be ground and macerated with the ore, either wet or dry. Not having the facilities, these experiments have proved rather difficult. A limited number of experiments with fresh sage-brush, greasewood, and other plants, have shown that the plan is workable, but certain elements enter into such a scheme to make the results uncertain. These crude experiments, nevertheless, may offer a valuable suggestion and may possibly inspire someone else to conduct experiments along this line.

C. T. B.

Los Angeles, March 31.

Mining: The Great Adventure

By T. A. RICKARD

*In the book of Job it is written: "Surely there is a vein for the silver and a place for the gold where they fine it." The miner, in a cynical mood, has been heard to misquote these words of the old Hebrew poet and say: "There is a place for silver, and gold is where you find it." The word 'fine' in the Bible means 'refine,' of course, and, therefore, to say that there is gold where it is refined is like telling the prospector that the precious metal of his search is to be found at the mint. But the patient Job was not a man likely to trespass upon the patience of his fellows: the Revised Version puts a comma after gold and says, "which they refine." So the miner's saying, which most of us have often heard, is without biblical warrant. Yet I venture to tell a story of a later day in which the same idea found humorous expression. In November 1851, soon after gold had been discovered at Ballarat, in Australia, Charles J. Latrobe, the Lieutenant-Governor of the young colony of Victoria, rode to the diggings, then the scene of feverish activity. Passing along the flat at Golden Point he watched the miners at work and talked with them. Finding himself chatting with a man of more than average intelligence, he put forth the great conundrum: "Where do you think the gold came from?" The old Cornishman—of course, he was a Cornishman—leant on his shovel, scratched his head for a moment, and then answered: "Well, sorr, wheer it is, theer it is; and wheer it ain't, theer be I." That reply remains to this day the epitome of geologic vision and mining realization. Nevertheless the diggings at Ballarat furnished the setting for one of the world's biggest adventures. What a 'rush' that was! Sailors deserted their ships, clerks jumped off their stools, traders abandoned their counting-houses, every able-bodied man shouldered his blanket and made tracks for the gold mines. The news reached Europe and started a stampede. Ships came crowded with people so unsophisticated in mining that they thought gold in quartz meant that the metal was to be found by the double-pint. They had much to learn, like most of us, and they were taught, as most of us are, by that supremely wise and forceful teacher, the professor whose name is Experience. It was a great hegira. From the mining camps eager prospectors plunged into the 'bush,' the forest primeval that covered the habitable portions of Australia. They found more golden gravel and they discovered also the grassy uplands on which the Australian was to grow a later silver fleece, a source of wealth more abundant than the gold, and more beneficent.

This hint of the golden fleece recalls the adventure of an ancient day. According to the classic myth, Jason and his comrades sailed on the ship Argo from Thessaly, on the quest of the fabled Golden Fleece, which was in Colchis. The king of that country consented to yield the precious fleece if Jason would perform sundry prodigies, which would have been beyond his strength if Medea, the king's daughter, a typical wise woman, or witch, had not given him a charm that helped him in his hour of trial. By aid of this he won the prize. He seized the fleece and fled home with his sweetheart and friends.

The fable may be interpreted thus: The sacred ram, the fleece of which Jason sought, refers to the Tibareni, or sons of Tubal, whose name means 'hammer,' for Tubal was a smith—the first of a noble and numerous family. The Tibareni were a tribe that mined for gold near the northern shore of Asia Minor. They washed the gravel of the gold-bearing stream into sluice-boxes on the bottoms of which they placed sheep-skins to arrest the fine gold. When the time came to clean-up, they removed the sheep-skins, shook out the coarser particles of metal, and hung the fleece to dry, so that the fine gold might be beaten out of it and saved. Thus the Greek mariners heard of the land in which golden fleeces hung on trees in a sacred grove by the Euxine. Jason is the type of youth, the seeker who goes forth with his comrades across the sea on the miner's quest. He finds that he must perform prodigies of labor before he can win the precious metal. In winning it he is aided by the sorceress Science, the modern Medea, who shows him how to use the fleece for arresting the fine gold in the bed of the stream Colchis, and even explains to him that the natural grease on the wool serves to promote the adhesion of the particles of gold. Placer mining, the aid of science to industry, and even flotation, are typified in the story of the Argonauts.

We recognize the undying truth of the ancient myth and speak of the Golden Age in California, of the Argonauts of '49, and of the Eldorado that they found in the foothills of the Sierra. Thus we mingle two tales, that of Colchis, and that of a fabled land called Eldorado, which, however, referred originally not to a country but to a person—*el dorado,* the gilded one, or *el hombre dorado,* the gilded man. In the spacious times of Queen Elizabeth, the sailors and buccaneers that sailed for the Spanish main were lured by the tale of Eldorado. Raleigh and his men, like Pizarro and his followers, heard the story so often that it seemed to become true by much telling. Juan de Ampues in 1527 found the tradition full-fledged among the Coquetios Indians in Venezuela. According to them, there dwelt a fierce tribe in the southern mountains where gold was so abundant that the Indians powdered the whole body of their chief

*An address delivered on the occasion of Commencement at the Colorado School of Mines, May 25, 1917.

with the dust. This tale of the gilded cacique became the will o' the wisp of mineral exploration, the something beyond the range that enticed the prospector of a romantic epoch across the swamps, into the jungle, and over the snowfields of the Andes into those mysterious forests that cloak the interior northern parts of South America.

One of the later versions of this myth referred to the Chibchas, a semi-civilized race dominating the plateau of Santa Fé de Bogotá, in Colombia; their chieftain, on the occasion of a high festival, would strip himself and be aneinted by the priests with mud from a sacred lake; they would then blow gold-dust upon him, gilding him from head to foot, in which guise he would perform the religious ceremony in honor of the Sun. Thus Colombia shared with Venezuela the honor of being the cradle of this legend, which, furthermore, declared that there existed a great interior sea, in the centre of which there was an island, upon which stood the city of Manoa, where gold was so abundant that the roofs were made of it and the streets were paved with it. Exploration drove this lake out of Colombia and then out of Venezuela; it retreated into the vague hinterland where the Rio Negro and the Orinoco have their source, but so persistent was the belief in the story that all maps of South America, from the first attempts at accurate cartography by Padre Fritz in 1616, down to the school-maps published as late as 1840, in the United States, showed this lake with its city of Manoa. Slowly the lake shrank on the maps and its position shifted uneasily until it became hidden in the last unexplored portion of the Amazon valley, the territory of the Roucouyennes, at the foot of the Tumac-Humac mountains, in Brazilian Guiana. Finally, about 35 years ago, Jules Crevaux, an intrepid French explorer, followed the legend to its last abiding place. He found that the chief village of the Roucouyennes was on a slightly elevated plateau in this low-lying region, and on the plateau there dwelt a tribe of Indians of great stature and of light color. He ascertained, by residing among them for two years, that they held an annual festival at which the chief was anointed with oil, after which he was dusted with mica from the schist of the Tumac-Humac mountains. This chief, being oiled, was covered with the yellow spangles of mica, the 'near-gold,' 'tender-foot' gold, or 'new-chum' gold, of the unsophisticated. And so the bubble was pricked—another suggestion of flotation. According to the technology of today the oil ought to have enabled the bubble to survive—but perhaps that idea too will prove to be a myth before many years are gone.

Thirty years ago, losing my way among the foot-hills of the Sierra Nevada, I stumbled upon a deserted mining camp—half a dozen bedraggled shanties, abandoned prospect-holes, deserted save for a couple of wretched Chinese coolies. The name of this derelict of mining was Eldorado. The word threw a halo of romance around those empty cabins in the silent pine-woods. No 'deserted village' of poetry was this, yet even 'Sweet Auburn' suggested sentiment less poignant: from Eldorado to empty shacks, from extravagant expectation to bitter disillusion.

South America had its gilded man, but California had its golden age. What a colossal adventure that was! It involved so much more than mines, and John A. Sutter was the central figure of the story. A Swiss, at the age of 31 he came to New York and migrated to Missouri, where he heard enough about California to want to go thither. He achieved his purpose in a roundabout fashion; proceeding in 1838 across-country to Vancouver, thence to the Sandwich islands, where he found no vessel going the way he wanted, so he sailed to Sitka, in Russian Alaska, and from there, at length in 1839, reached Yerba Buena, the little settlement that is now San Francisco. Accompanied by the eight Kanakas that he had brought with him, he sailed up the Sacramento river and established himself at New Helvetia, now Sacramento, where he erected the stockade that became known as Sutter's Fort. At that time the Mexican ruled California, but the Russian also had a foot-hold. Fort Ross and Russian river, in Sonoma county, are names that but vaguely recall an incident that might have had quite another meaning. It was there in 1812 that a Russian farming settlement was established by an expedition, under Alexander Kuskoff, from Sitka. This Russian post was due to the far-seeing design of that Nicolai Rezanoff whose romance with Concepción Arguello, the commandante's daughter at the Spanish fort on San Francisco bay, is preserved in Bret Harte's verse. Rezanoff won her love, he was recalled to Russia, expecting to return, but he died by an accident on the way and with him perished not only a dream of empire but the happiness of a woman.

"So each year the seasons shifted—wet and warm and drear and dry;
Half a year of clouds and flowers—half a year of dust and sky;

Yet she heard the varying message, voiceless to all ears beside;
'He will come,' the flowers whispered; 'Come no more,' the dry hills sighed.

Still she found him with the waters lifted by the morning breeze—
Still she lost him with the folding of the great white-tented seas."

The Russian colony in Sonoma did not prosper. In 1839 it was offered for sale to the Hudson's Bay Company, and in 1840 to the Mexican government of California, but it found no purchaser. Thereupon Sutter, whose fortune was in the ascendant, appeared on the scene, and on December 13, 1841, he bought the entire property, with its cattle and improvements, for $30,000. The Russian garrison embarked in February 1842. That ended the Russian occupation in California. Sutter sped the parting Russians with his left hand and welcomed the arriving Americans with his right. His ranch on the Sacramento river stood in the track of the pioneer bands that were beginning to cross the Sierra Nevada into the great valley of California. Although he had become naturalized a Mexican, he disregarded the Governor's polite request to oppose the invasion of new-

comers from the United States; instead, he gave them the 'glad hand,' foreseeing that they were likely to become the masters of the country. That was five years before the discovery of gold. He organized a military company and played a half-hearted part in the revolutionary troubles of Alta California, as this Mexican province was called. When Mexico and the United States went to war he raised the American flag over his stockade on July 8, 1845. He served as Indian agent for the American administration and proved himself a good citizen in many ways. But his great opportunity was yet to come. A shrewd man, he saw that the influx of settlers would create a demand for lumber; so he started to build a saw-mill. He engaged James W. Marshall, a carpenter from New Jersey, to build the saw-mill at a place called Coloma on the south fork of the American river. How these names—Marshall, Coloma, American river—vibrate with romance! You know the story of the gold discovery, yet I dare to repeat it.

When the saw-mill had been built, Marshall found that the tail-race was not deep enough, so he scoured it by opening the water-gate to full capacity. The water ran all night, and in the morning he closed the gate while he examined the mill-race to see if it had been sufficiently deepened. In the gravel loosened by the current he saw several bits of yellow stuff. He took one of the nuggets and hammered it, proving that it was metallic; he bit it and found that it was soft; he put it into the soap-kettle of Mrs. Weimer, who was cook for the mill-hands, and it emerged bright but insoluble. Thereupon he decided that it must be gold. At once he went to New Helvetia, 53 miles distant, to tell Sutter about the discovery. Locking the door of Sutter's office, he pulled out a rag in which the nuggets were wrapped. Sutter applied the acid test, having some nitric acid among his apothecary stores; he read the article on 'Gold' in his copy of the Encyclopedia Americana; he weighed the specimens and compared them with gold coins; whereupon he pronounced it 23-carat gold. And his dictum spoken in that frontier store went out to all the world; at first a whisper, then a mighty shout, it called the adventurous of every land to California.

But Marshall did not profit from it, nor did Sutter. His laborers left the saw-mill, his staff at the ranch decamped for the diggings. The mill was deserted and even the mill-stones were stolen; his tannery went to ruin; even the Indians refused to harvest his crops; the miners stole his cattle and rode off on his horses; prosperous before, Sutter was beggared by the gold-seekers and by the conditions they created. Nothing remained but for him also to search for gold. He organized a prospecting expedition, but it was a failure, and, in the end, he had to be pensioned by the State of California. Marshall also received some little help from the State, but he died a poor disappointed man. In 1851 California yielded $81,294,700 in gold. The date of the discovery was January 24, 1848, and the treaty of Guadalupe Hidalgo, ending the first Mexican war, was signed on February 2; in other words, California was ceded to the United States nine days after the fateful discovery, no whisper of which had reached either of the signatory governments. Sutter and Marshall kept the news from spreading as long as they could. What would have happened if Marshall's find had been made one year earlier? Would Mexico have yielded so rich a mineral domain, which included Nevada, Utah, Arizona, and part of Colorado also, for $8,250,000, even at the point of the sword? Would Russia and England have acquiesced in the cession so unconcernedly? It was a wonderful coincidence—as remarkable as the fog that prevented Drake from discovering the Bay of San Francisco in 1578. We may well be grateful for the fact that the discovery of gold did not come to create a bone of bitter contention but to stimulate the founding of a great commonwealth.

Soon the wilderness west of the Missouri river was threaded by long trains of wagons bearing the gold-seekers to California. So eager were they to reach the new Colchis on the Pacific Coast that they had no time to examine the signs of mineral wealth strewn on the barren ridges rising above the dreary desolation over which they trekked. Many of them entered California by the trail that followed the Carson river to the crest of the Sierra, south of Lake Tahoe, and then descended among the pinewoods of Placerville, where they went to work with pan and shovel in the gold-bearing streams tributary to the American river. The Carson valley became a resting-place on the road. It was an oasis in the desert pilgrimage. That migration was like the march of an army of camp-followers; it included all sorts and conditions of men and women, even children. Among others a party of Mormons came westward from Salt Lake City in 1849, and one of them, William Prouse, of Cornish origin, panned gold in a little creek that entered the Carson river from the west, where the town of Dayton now stands. The gravel was not rich enough to beguile the prospector from the larger lure that lay across the mountain rampart separating from California what was then part of Utah, but is now Nevada. That little creek became known as Gold Cañon; it was the door to one of the treasure-vaults of the world—the Comstock lode. After the Mormons had passed, a group of Mexicans, from Alamos, in Sonora, tried to work the gravel with their bateas, separating the gold from the debris by 'dry-washing,' using air instead of water as the medium for their concentrating process. But their winnings were small and supplies of every kind were so costly that no ordinary yield would suffice. So they also quit. Others came, for the diggings were near the overland trail. A little camp was established in Gold Cañon in 1851. Long-toms and rockers became numerous, and the placer miners slowly worked up the creek toward the great vein from which most of the gold had come. About $100,000 worth of gold was extracted annually until 1857, by which time the gravel in the lower part of the creek and on the bars of the Carson river had been pretty well worked out.

We may feel surprise that the indications of greater riches in the outcrop that crossed the ravine near its head were ignored so long, but we who have read last

year's almanac and can view the signs of ore in the light of later knowledge must make allowance for the complete ignorance of vein-structure and ore-distribution prevailing among those early prospectors. Besides, the miners that were content to make a few dollars a day in Gold Cañon were a shiftless, ignorant, sodden lot. Not all of them; among the illiterate mob that found slim pickings in the gulch were two brothers named Grosh, the sons of a clergyman in Pennsylvania. They came to Gold Cañon from the Californian side, having had some experience in Eldorado county. They were intelligent and observant young men, and they went up the gulch to find the source of the gold. In 1856 they wrote to their father telling him that they had found silver, "it resembles thin sheet-lead broken very fine, and lead the miners suppose it to be." The placer miners had often complained of the heavy mineral, called by them 'sand of iron' and 'blue stuff,' that clung to the bottoms of their sluice-boxes and clogged their. rockers. They had no idea that it was hornsilver and argentite. Later the Grosh brothers reported the finding of "two veins of silver at the forks of Gold Cañon . . . one of these veins is a perfect monster." This was the outcrop of the Comstock lode. Their first assay of the 'black rock' showed $3500 per ton in silver. A reference to cupellation suggests that they had a portable muffle-furnace. Thus they prospected for silver when not earning a bare living by washing for gold in the gulch. Their hands had touched the Great Bonanza, but they did not know it and they did not live to profit from it. Tragedy dogged their footsteps. First their backer, George Brown, a cattle-trader in the Carson valley, was murdered. Then one of the brothers, Hosea Grosh, died from the effects of an accident to his foot. Finally, the other brother, Allen, died from exposure while crossing the range into California during the winter of 1857. His papers were thrown away when he and his companion, Richard Bucke, were struggling in the snow. Bucke barely survived, and after regaining some measure of strength betook himself on bandaged stumps to Canada. So the heavy hand of misfortune erased the exploratory work of these intelligent young men, and it was left for a drunken loafer and a shifty imposter to give their names to Virginia City and the Comstock Lode. The heirs of the Grosh brothers later engaged in long and costly litigation in an effort to enforce their claims, but without success.

James Finney, a native of Virginia, known therefore as 'Ole Virginny,' a prospector during sober intervals, was rambling along the hillside above Gold Cañon when he espied an outcrop of quartz. Thinking it might denote a vein, he wrote a location notice on a slip of paper, which he hid among the loose stones. This was on February 22, 1858. He did not record his claim, he made no attempt to work it, and it proved of no consequence except as the excuse for an unsuccessful lawsuit. Subsequently he noticed a mound about a mile south of his location and early in 1859 he and some others panned some crumbly earth that they found at a gopher-hole on the edge of the mound. It was so rich in gold that they staked four claims of 50 ft. each. This mound was part of the outcrop of the big lode and became known as Gold Hill; it was a veritable golden hill, for it all passed through the mill in the course of a few years, and in its place was a big 'glory-hole.' Meanwhile other placer-miners working up a gulch to the north, at the head of Six Mile canyon, had moved so far from the creek-beds that two of them, Patrick McLaughlin and Peter O'Riley, were no longer washing alluvial ground, but the debris of erosion. This was at the mouth of Spanish Ravine, more than a mile north of Gold Hill, but they also were working just below the outcrop of the great vein, which extends north and south for several miles. McLaughlin and O'Riley were not doing well at all, the surface did not yield much gold, and they had only a trickle of water, which they had to conserve carefully. On the 8th of June, 1859, while digging a water-hole, they noticed that the earth contained yellowish sand, bits of quartz, and pieces of black rock. This was material of an unfamiliar kind. However, they had to try it, so they washed a little of it in their rocker and were astounded to see the gold that was left on the bottom. They tried some more of it, with a similar result. The metal was of a pale color—on account of the silver alloyed with the gold—but still it looked good enough. They were overjoyed. Just then a lank fellow on a small horse came riding toward them. It was Henry Comstock, formerly a fur-trader and trapper in the North, a talkative trickster. He caught sight of the gold and saw that something rich had been uncovered. Dismounting, he fingered the gold and asked some questions. Cooly he informed the two Irishmen, who had staked two claims, that they were trespassing on his property. He asserted that he had a ranch of 160 acres covering the ground, which included the water-hole and the trench in which the prospectors were at work. It was all bluff—a rank imposture—but he talked so loudly and so confidently that McLaughlin and O'Riley thought it best to pacify him by acceding to his demand, which was that he and his partner Penrod were to be given an equal share in the discovery-claim. It is a remarkable coincidence that the placer miners in Gold Cañon and those in Spanish Ravine should have, independently, worked up to and discovered the great lode at about the same time. Meanwhile, a meeting of miners had been called to frame regulations for a new mining district, so, in order to obtain an undisputed right to their claims, Comstock and his three partners concealed the discovery by filling the hole and obliterating other traces of their work. The meeting was held on June 11; next day Comstock and his partners, over whom he had easily asserted loud-mouthed leadership, located 300 ft. for each man and an additional 300 ft. for the discoverers, making 1500 ft. in all along the lode. At the southern end of the lode, at Gold Hill, the miners took up much smaller claims, being governed, apparently, by the custom regulating placer locations. The summer of 1859, until the Nevada City quartz-miners arrived on the scene, was spent in feverishly washing the rich earth in the small gulches along the lode. These ignorant placer-

miners did not realize that they had uncovered a great vein. The pieces of black rock and dull metal were thrown aside. At a depth of four feet, McLaughlin and O'Riley cut into a seam of black stuff several inches thick, but it was regarded as a nuisance only. The loose earth became clotted with the soft yellow sand, so that it could be washed no longer in a rocker. Thereupon two arrastres were procured. For these two arrastres, and the two horses required to operate them, the claim-holders traded two-sixths of their property. By aid of these Mexican milling-machines they began to make money fast, for the grinding-stones crushed the yellow sand, which was silver chloride, so that it amalgamated readily. The black rock or 'blue stuff,' as they called it, was still neglected. Its value did not become known until several specimens of it were carried by a farmer from Truckee and by him given to two competent assayers at Nevada City. At last the ore had passed into the hands of capable investigators. They assayed it and found that it was worth $1595 in gold and $4791 in silver per ton. The mineral was argentite containing native gold. That night two capable miners, Judge Walsh and Joe Woodworth, loaded a pack-mule and started on horseback for the discovery, and within a few days hundreds of men followed them. The 'Washoe rush' had begun. Walsh and Woodworth got there first and bought out Comstock and his partners for a few thousand dollars. The original prospect-hole of McLaughlin and O'Riley became the Ophir mine, which has yielded $17,655,000; the stopes of this mine grew so unmanagably large that the square-set system was devised by Philip Deidesheimer to keep them open. If the true discoverers, the Grosh brothers, failed to achieve success, it is also a melancholy fact that the other actors in the drama profited but little from the Great Bonanza. Comstock died miserably, by his own hand, in 1870, and both of those whom he partly dispossessed died paupers and without honor.

The discovery of the Comstock was almost as fortuitous as the finding of a purse in the street by a drunken sailor. The placer-miners knew little about vein-mining and nothing about silver-mining. The mining of silver was unknown in the United States previous to the discovery of the Comstock and the knowledge of minerals, as also knowledge in general, was lacking in the cabins of Gold Cañon. But the opening of the great treasure on the lower slopes of Mount Davidson brought to the Comstock all the sciences that were needed to guide skilful exploitation. The figures of production are staggering. The entire output of gold and silver exceeds $500,000,000. In the early years, the value of the gold in the ore exceeded that of the silver. Of the total production of the mines, about 56% of the value was silver and 44% was gold. The losses made in milling and the money stolen are not recorded, but they form part of the yield of the great lode. By 1867 the shallow orebodies were exhausted, and the future looked dark. Then, in 1870, the Crown Point found its famous ore-shoot at a depth of 1100 ft. and the Comstock took a new lease of life. In 1873 the Consolidated Virginia Mining Company, generally known as the 'Con. Virginia,' found the top of its ore-shoot at a depth of 1100 ft. from the surface. This orebody extended into the California; it yielded $131,759,399 in metals and $78,148,800 in dividends up to the end of 1899. Nearly all of this was produced in five years, from 1874 to 1879, during which 1,000,000 tons was mined that averaged about $100 per ton. For three years, after the big orebodies were uncovered between the 1100 and 1600-ft. levels, the Con. Virginia and the California produced $3,000,000 per month, and dividends at the rate of $1,080,000 per month were paid by each mine. This enormous production incited an orgy of stock-gambling in all the mines along the Comstock lode, good and bad. There were only a few richly productive mines, a few more that found ore but paid no dividends, and a flock of others that never paid anything but 'Irish dividends,' that is, did nothing but collect assessments year in and year out for a generation or more. The stock-gambling excitement, however, kept these alive. The discovery of ore in any one mine greatly affected the value of all stocks, and the fluctuations of the market were almost incredible. Mines sold for millions that never had a pound of ore. Wallingford might have taken lessons from some of those early Comstock manipulators.

In 1871 the mining properties that became merged into the Con. Virginia and the California had a market-value of less than $50,000. In 1875 the shares of these two mines were valued at over $160,000,000. An earlier instance of a remarkable rise in stock was that of the Crown Point, the shares of which rose from $2 to $1825 in less than a year. In these two instances, however, the discoveries were of such size and richness as to justify the market. In 1875 Philip Deidesheimer estimated that the Con. Virginia bonanza would produce $1,500,000,000 and he and his friends went bankrupt on that appraisement. Within eight months, in 1878, the shares of the Sierra Nevada mine rose from 50 cents to $275 per share, but this rise was based on nothing but market manipulation. One thousand dollars was sometimes turned into half a million in less than a year. Money was made easily and lost recklessly. The Comstock became a byword for tricky dealing, extravagant management, and fickle fortune. It had a wonderfully fascinating history, however, and its gold and silver enabled the battle-born State of Nevada to enrich the Nation in an hour of need—the Civil War.

The gold and silver have been spent, but there remains much that time cannot destroy. The art of mining was developed by the men that pierced deeply into the roots of Mount Davidson; some of those who won wealth at the point of the pick took their places among the Napoleons of finance; others became captains of industry. Mark Twain has peopled Virginia City with characters that will live when the underground galleries are sealed by the healing processes of nature. I visited Virginia City a few years ago and stood on the ground where geologic agencies had accumulated a treasure beyond a pirate's dream.

"Cold upon the dead volcano
Sleeps the gleam of dying day."

The sunlight fell on abandoned shaft-houses, the rain had rusted the motionless machinery, and far below was the canyon where the first diggers delved and died. The stream survives their interfering labors and now the Chinaman uses it more productively than the miner.

"The river still is winding, still is winding,
Past the gardens where the Mongol tends the cabbage and the leek."

Another fabulous source of gold was Ophir, whence Solomon is said to have obtained his wealth; although he probably acquired most of it by reason of the fact that Jerusalem was on the great caravan route between the Nile and the Euphrates. At various times every ancient digging near the Red Sea or the Indian Ocean has been put forward as a claimant for the honor, from Nubia to Kolar, from Abyssinia to the Mountains of the Moon. Dr. Carl Peters thought he had found it at Fura, a corruption of the word Ophir adopted by the Portuguese from the Arab traders; hence 'the gold of Arabia.' Fura is in the Zambesi region. Even the word Africa has been traced by an etymological twist from Ophir, through Afir, Afer, and Africus. Wherever Ophir was, the output of gold must have been stupendous, according to biblical statistics. In First Chronicles XXIX, 4, it is written that King David contributed to the building of the temple "three thousand talents of gold, of the gold of Ophir." A talent is equal to 114 pounds troy, so that the 3000 talents represented over $80,000,000 of our money. In the same context it is written that the fathers and princes of Israel contributed 5000 talents and 10,000 drachms of gold "for the service of the house of God." That means $135,000,000 more. There were great stores of gold in Egypt and the Euphrates valley and throughout Asia Minor long before the times of David and his son Solomon, and it was undoubtedly derived in large part from placer mines. Herodotus speaks of gold being so common in Ethiopia (Abyssinia) that they used chains of it to fetter slaves. Copper was the precious metal because of its scarcity. In recent years the mighty ruins of Zimbabwe, in Rhodesia, were identified as Ophir, until an unromantic archeologist spoiled the fancy. Wherever it was, we know that the quest of Solomon's mines stimulated prospecting in the heart of Africa and opened the dark continent to modern industry. Among other adventures due to this search I may relate that of the expedition to Mashonaland, a company of 187 courageous and energetic men, organized by Cecil Rhodes in 1899 to penetrate the region north of the Transvaal and west of Portuguese East Africa. The country of the Mashonas had been identified as the place of Ophir and King Solomon's mines by a German explorer, called Mauch, who spread tales of a hidden Eldorado among the Boer vortrekkers. The expedition sent by Rhodes was commanded by Major Frank Johnson, now a chairman of mining companies in London; it was guided by F. C. Selous, the celebrated big-game hunter of Africa. This company of men, called the Pioneers of Mashonaland, set out to explore the region, to make a road, and to commence mining. Their safety depended upon the word of Lobengula, the chief of the warlike Matabele, who had given Rhodes a concession. "There is a wall built round the word of a chief," the old warrior said, and he proved it. The expedition was subject to attack from other quarters, not to mention malaria, and the venture was hazardous. It was a big grubstake on the part of Rhodes and his British South Africa Company, which he had organized for exploratory expansion in what he was fond of calling the 'hinterland.' The men that set out on this trek were a fine lot: soldiers, athletes, hunters, miners, frontiersmen of the best kind. At Tuli they crossed the northern border of the Transvaal and there began to clear a road through the bush as they advanced. As the trees were cut down the heavy ox-wagons made ruts that defined the road and extended the trail of empire into the wilderness. Selous led the way. He was then 40 years old; 20 years earlier he had stood before Lobengula and asked permission to hunt elephants and lions. The old warrior laughed, but gave the permission. When the news of the boy's exploits reached the great chief he swore a mighty oath and proclaimed the young Englishman the greatest of all hunters. The Pioneers loved him. He was a fine figure of a man, deep-chested yet nimble—the Allan Quatermain of Haggard's story. His voice was well modulated and his eyes a clear blue. "A mighty hunter before the Lord" was he, fearing neither man nor beast. Twenty-five years later, in 1915, when 64 years old, he obtained a commission and joined the British forces that were fighting the Germans in East Africa. In September 1916 he was promoted to captain and awarded the D. S. O. "for conspicuous gallantry, resource, and endurance." In January of this year he fell while leading his men in battle. He was shot and mortally wounded, but continued to urge his men forward until he was hit a second time, fatally. When the news of his death reached New York, another fearless man and mighty hunter, Theodore Roosevelt, said: "It was a fit and gallant end to a gallant and useful life." A son of Selous is now serving in France. Let us claim him as one of the heroic band of prospectors that have opened the waste places of the earth to human enterprise.

On September 12, 1890, the Pioneers of Mashonaland completed their trek of 430 miles and founded Salisbury, taking possession of the country in the name of the British South Africa Company. Having finished the first portion of their task, they grouped themselves into little syndicates and prepared to seek for gold. Each syndicate had a wagon and a span of oxen, rations for three months, tools, dynamite, and other supplies, besides goods for trading with the natives. The expedition had been followed by a number of prospectors, who now scattered over the surrounding region. It was the expectation of Rhodes and his associates that lodes richer than those of the Rand would be found and that in a short time the discoveries of gold would attract a large population. This hope proved fallacious. Gold was found in the Hartley hills, Gatooma, Lomagundi, and other districts,

and eventually a number of productive mines were developed, but the mining industry never grew to lordly proportions. Many of the mines were founded on ancient workings, usually about 50 feet deep, dug by a forgotten people. However, if the immediate results seemed unimportant the ultimate consequences proved far-reaching. This band of pioneers prepared a way for others, they started the mineral exploration that opened the interior of South Africa to orderly development, they broke the ground for peaceful agriculture and civilized habitation from the Cape of Good Hope to the sources of the Nile.

One more story: that of the three lucky Swedes, as they became known in the North. John Brynteson was a Swede who had worked in the iron mines of Michigan. Erik Lindblom, another Swede, was a tailor in San Francisco when the lure of gold called him from the bench to Alaska. Jafet Lindeberg, a Norwegian, came to Alaska in charge of the herd of reindeer that the United States government brought over from Lapland. These three men chanced to meet at Council, on the Seward peninsula, in August 1898. Lindblom was 44 years of age, Brynteson 28, and Lindeberg only 22. They formed what Lindeberg called "a prospecting companionship," a little company of honorable adventurers in search of the Golden Fleece. They were energetic and intelligent fellows. While prospecting roundabout Council they studied the methods of placer-mining and took pains to learn the mining regulations; finding that all available ground in the district had been over-run by stampeders and staked to the mountain-tops, they decided to go elsewhere. Brynteson had been farther up the coast with some other prospectors just before he met Lindeberg and Lindblom, and he told them of the finding of gold in the creeks at the upper edge of the coastal plain. So they left Council and went down to Golovin bay, where they procured a boat and provisions. They set sail September 11, 1898, on a voyage that proved eventful. Proceeding along the coast they stopped at the mouths of the streams that flow into Bering Sea; they did some prospecting, but not finding enough gold, went farther west to where the Snake river meanders through the tundra to the sea. This became the site of Nome. It was about 100 miles from their starting point. Having been to Nome, I can picture the desolate landscape—then absolutely devoid of human touch—the chill gray waters lapping a long beach fringed by the moss-covered plain stretching to forbidding hills. They did not linger on the seashore, although the beach-sand showed some gold. They ascended the slow-flowing river in their boat as far as the mouth of a creek where Brynteson had panned gold on his former trip. Lindeberg was quick to infer that the gold on the shore must come from up-country, and determined to search for its source. They prospected several creeks the names of which now to an Alaskan are as eloquent of gold as Colchis or Pactolus to Macaulay's schoolboy. It is a remarkable fact that these three men, novices in alluvial mining, should have been able, after a hasty inspection, to select what later proved to be the richest portions of several creek-bottoms. They located a joint discovery-claim on Anvil creek, and then each located a claim in his own name on this creek as well as on Snow, Glacier, and Rock creeks. They knew what they were about; they showed rare judgment in locating, and they took pains to comply with the law. All of these claims were subsequently consolidated under the name of the Pioneer Mining Company of Seattle, and Mr. Lindeberg became the president of the company. When the three prospectors returned to Council, in October, the news of the discovery soon spread, causing a rush. A party was organized by the three Scandinavians and three others, who went to the mouth of the Snake river and organized the Cape Nome mining district. The whole country was soon plastered with locations, most of them illegal. The prospectors that had done the first gold mining in this region, the Seward peninsula, were chagrined to find that the three Scandinavians, comparatively inexperienced as they were, had located the best claims; so they jumped the claims of Lindeberg and his partners on Anvil creek, and set an example that was followed at once by the crowd of newcomers. Every claim was covered two or three deep with locations. Anarchy ensued, culminating in a disgraceful litigation, rendered long and costly by a gigantic conspiracy on the part of the local authorities established at Nome. Never was the law worse prostituted by graft, and never did a man fight more courageously and fairly against big odds than Lindeberg on behalf of his 'prospecting companionship.' To the honor of American journalism be it said the *Washington Post* was instrumental in exposing the whole shameful story, causing the Senate to call for an investigation. The Federal court at San Francisco, notably Judge Morrow, checked the outrage and prevented the robbery from being consummated while investigation was being made. The judge at Nome was dismissed and a great wrong righted. Lindeberg came into his own, after a fight that had lasted three years. He proceeded to exploit the gold-bearing creek-bottoms in a miner-like way and organized a thoroughly efficient enterprise, which proved highly profitable. The Pioneer Mining Co. has produced $17,000,000 in gold, of which $6,000,000 has been distributed in dividends and $4,000,000 spent in property and equipment. It is still productive. And when he had made money Mr. Lindeberg did not forget his native place, Tromsö, but furnished funds for building schools, giving to his younger countrymen some of the educational advantages that he had been compelled to acquire as best he could during the rough and tumble of his great adventure.

This is the story of a recent day. The heroes of it are living and working still. It is a pleasant story, because it tells of wrong righted and of intelligence rewarded. The ignorant and the envious among their fellows exclaimed at the "stupid luck" of the gallant three, but it is a fact that they prospected on every claim that they staked, they worked diligently, and they ascertained where lay the richest ground before their locations were made. They were wise also in studying the mining law before they started on their exploration, so that they

knew how to comply with it in every detail when the time for action arrived. They were strong men, as able to withstand the attack of unscrupulous foes as they were fit to face the hardships of a stern cold land. Such are the true sons of the North, not the dissolute weaklings or the unhappy misfits of a material civilization but the men with the heart of a viking and the faith of a child, to whom the call of adventure is as the voice that the caribou hears in the spring. Every young miner hears that call.

"Something hidden. Go and find it. Go and look behind the ranges—
Something lost behind the ranges. Lost and waiting for you. Go."

You will go, will you not? You will light your campfires in the solitary places and steer your boat amid uncharted seas. You will

"Whistle bits of rag-time at the end of all creation,
And learn to know the desert's little ways?"

"They have cradled you in custom, they have primed you with their preaching,
They have soaked you in convention, through and through;
They have put you in a show-case; you're a credit to their teaching—
But can't you hear the Wild? It's calling you."

Let us probe the silent places; let us seek what luck betide us;
Let us journey to a lonely land I know.
There's a whisper on the night-wind, there's a star agleam to guide us,
And the Wild is calling, calling . . . let us go."

But I must not stop here. To you, today, comes a higher call, the call to serve your country even in the cannon's mouth. You are drawn by the romance of a greater adventure than any of which I have spoken, by the greatest of all adventures, that in which a man risks everything, not life alone, but his ambition and his career, in order to fight for the noblest of all causes, that of national honor and human freedom. The world cannot remain "half slave and half free." Representative government must not perish. Civilization shall not be mocked by deliberate wrong and bestial cruelty. It is for you to carry the flag of Washington and Lincoln to the forefront of the battle to ensure "life, liberty, and the pursuit of happiness" not only in this great land but wherever the human spirit breathes the hope of higher things. You will answer that call, you will play your part in that proud adventure, you will acquit yourselves like men, so that not this nation only but the whole world "shall have a new birth of freedom, and that government of the people, by the people, for the people, shall not perish from the earth."

TIN is dissolved by the acids present in fruits and vegetables. Even foods of relatively slight acidity will dissolve tin from the walls of the can, which is then adsorbed from the solution by the proteins and carbohydrates. It is not known whether this action is due to direct adsorption of the tin ions, or whether the tin-salt is first hydrolyzed and the resulting stannous hydroxide then adsorbed; in either case the acid is regenerated and will dissolve more tin from the can, so that the contents finally become highly charged with the metallic product. Among the canned foods that dissolve the largest quantities of tin are black cherries, raspberries, squash, string beans, red cherries, pumpkin, strawberries, and tomatoes, in the order named, the percentage of the metal in the ash ranging from 83 down to 38%.

Volumetric Chromate Determination of Lead

By JOHN WADDELL

*The method described is most satisfactory in those cases in which the molybdate method is least reliable, namely, with ores poor in lead and containing a large amount of calcium carbonate. It was originally proposed and used by H. A. Guess, but the results were not as closely accordant as desirable, and the modifications herein given have overcome the difficulties, and have been fully tested.

The method as originally given by Guess in the Transactions of the American Institute of Mining Engineers was as follows:

"To the ore-charge of 1 to 5 grammes in a 250-c.c. flask add from 3 to 5 c.c. of strong nitric acid and 15 c.c. of strong hydrochloric acid; digest until everything is in solution and the excess of acid has been reduced to about 8 c.c. The whole operation on the hot-plate requires but 15 min. The flask is then removed, and moderately diluted ammonia is added slowly in slight excess, the neutralizing action being sufficiently vigorous to render the content of the flask quite hot. Acetic acid, of 80% strength, is then added slowly, the flask being shaken vigorously until the smell indicates a decided excess. Then add 5 c.c. of strong ammonium acetate to insure the solution of any lead compounds remaining undissolved by the ammonium acetate already formed in the flask. If the ore contain no antimony or separated gelatinous silica, and if the silicious residue in the bottom of the flask is only in slight amount (as is usual with heavy lime ores or with concentrate), add to the hot undiluted and unfiltered solution an excess (about 10 c.c.) of a 10% potassium chromate solution. Under these conditions the bulk of the content of the flask will not exceed 50 c.c., and after shaking and letting the precipitated lead chromate settle for about five minutes the content is filtered through an 11-cm. filter of any fairly rapid and close paper. If these directions are carried out the lead chromate will be quite granular, and will show no tendency to run through. The precipitate in the flask and on the filter is washed several times with hot water containing about 0.5% of acetic acid until free from soluble chromates. The funnel with the filter is then set over the original flask and hot dilute hydrochloric acid (1 to 1) is poured through the filter, dissolving the lead chromate. Further additions of hydrochloric acid are

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made if necessary and all lead chromate is dissolved from the filter; it is then washed with warm water until free from chromate. The original flask now contains nothing but the hydrochloric-acid solution of the lead chromate and the washings which, after adding a small crystal of potassium iodide, from 0.5 to 2 gm. in weight, is titrated direct with standard 'hypo' solution the value of which is known in terms of lead, the most suitable strength being that in which 1 c.c. is equal to 5 mg. of lead. In this operation, by using only a small quantity of potassium iodide, and having the solution fairly strong with hydrochloric acid (about 50 c.c. of hydrochloric acid, 1 to 1, in a total of 200 c.c. of solution) and somewhat warm, any tendency of the lead to form yellow scales of lead iodide, and thus obscure the end-reaction with starch, is completely checked and the end reaction is sharp."

The sharpness of the end-point with starch, as opposed to the indistinctness of the end-point in the molybdate method, is given as one of the special features. Students working in my laboratory, and chemists in other places, have found difficulties with this method. Sometimes the blue color of the starch disappeared on the addition of thiosulphate, only to come back in a minute or two; in other cases the precipitate of lead chromate seemed not to be washed free from the soluble chromate in the course of an hour or more; sometimes even when no error was visible the results were not concordant. Since the method is exceedingly interesting, I investigated the points of difficulty. I found that treatment of the ore with hydrochloric acid before the addition of nitric acid is to be recommended, since it lessens the tendency to form a globule of sulphur which may enclose some lead. The effect of varying the strength of the acid used in the titration was first tried. To about 10 c.c. of a solution of chromate (9.5 gm. per litre) 200 c.c. of a mixture of strong hydrochloric acid and water, in which the acid varied between 5 c.c. and 100 c.c., was added, and after the addition of potassium iodide the iodine was titrated with thiosulphate. With small quantities of acid the blue color of the starch, after being first discharged, came back after a minute or two. With 5 c.c of acid the color was discharged and reproduced several times. It seems that there should be at least 25 c.c. of acid present. Titrations in which the chromate had been heated with acid for varying lengths of time between 60° and 80° C. showed in general partial decomposition, though the variations were not always of the order that might be expected. As there is evidently a time-reaction between the chromate, hydrochloric acid, and potassium iodide, the effect of varying amounts of iodide, up to 1 gm., was tested. The most concordant results were obtained by using one gramme of iodide, and by running in the thiosulphite drop by drop, about three drops per second, 1 c.c. of chromate in that case being equal to 1.968 c.c. and 1.976 c.c. of thiosulphate in duplicates. In this set of experiments 25 c.c. of acid, and 175 c.c. of water, were added to 15 c.c. of a chromate-solution measured by a pipette.

One source of error in the method was found to be the solubility of lead chromate in the 0.5% acetic acid used for washing. The addition to 50 c.c. of this acid of 2 or 3 drops of a solution containing less than 1% of chromate rendered its solvent action almost nil, and hence the acid may be used until nearly all the soluble chromate is washed out, but finally pure water is required. In order to avoid possible error from setting chlorine free by the use of half and half hot hydrochloric acid, I dissolved the lead chromate with a cold mixture of 25 c.c. of hydrochloric acid and 75 c.c. of water, washing alternately with this mixture and with cold water. From time to time 5 to 10 c.c. of hot water was used for the more perfect dissolution of the lead chloride.

The precipitate having been dissolved and washed into the flask, as Guess describes, the liquid was made up to about 200 c.c. and 1 gm. of potassium iodide was added, followed immediately, to avoid loss of iodine, by thiosulphate from the burette at the rate of 2 or 3 drops per second. After the brown color had nearly disappeared and had changed to a dark green, starch was added and the thiosulphate run in, a few drops at a time, with vigorous shaking. When the blue color was nearly discharged 10 c.c. of strong hydrochloric acid is added and the flask heated to 40° C., after which 2 or 3 drops of thiosulphate were sufficient to bring the clear green color of the chromic salt, which constitutes the end-point. On four determinations, taking 0.5 gm. of ore there was required 28.30, 28.40, 28.28, and 28.30 c.c. of thiosulphate. The lowest and highest figures give respectively 27.76 and 27.88% lead. The difference between the Guess method of solution of lead chromate and the one here adopted was tested by sprinkling basic lead chromate upon two filters and dissolving one quantity with nearly boiling 1 to 1 acid and the other in the manner described. In the first case 1 c.c. thiosulphate = 0.01516 gm. chromate; in the second 1 c.c. thiosulphate = 0.01446 gm. chromate. Assuming that the second determination was correct, the 0.4336 gm. of chromate used in the first case should have required 29.99 c.c. of thiosulphate instead of 28.60 c.c., which was actually used. With starch iodide paper, chlorine can be readily detected when hot 1 to 1 hydrochloric acid is put upon lead chromate.

In the presence of large quantities of iron, as for example 20%, the tendency to form basic acetate gives difficulty in dissolving the lead. Of course, any ferric acetate precipitated along with lead chromate is fatal. Guess points out that the presence of antimony, bismuth, silver, or gelatinous silica, interferes with the process, but says that if the lead is first changed to sulphate and, after separation from the soluble sulphates, dissolved in ammonium acetate, as for the molybdate determination, the rest of the process may be carried out as before. In this case the sole advantage in the chromate method is its delicacy; it takes a longer time, but duplicate determinations should check within a tenth of one per cent, and often do check within two or three-hundredths.

American Smelting & Refining Company's Tests With Sulphur and Sulphuric Acid on Soils

By P. J. O'GARA

In agriculture it has long been recognized that the essential elements of plant-food are nitrogen, potassium, phosphorus, calcium, magnesium, carbon, hydrogen, oxygen, iron, and sulphur. It is also recognized that other elements, while not essential, are more or less beneficial. It is well understood, of course, that plants cannot use the elements as such, but make use of them in the form of water-soluble compounds; for instance, sulphur cannot be used by the plant as sulphur, but as a sulphate; nitrogen cannot be used as nitrogen but as a nitrate, and so on. Until recent years, although sulphur has been considered one of the essential plant-food constituents, it has been given a relatively secondary place. The earlier analyses of plants showed that sulphur was not found in them in amount equal to some other elements, the element phosphorus being one in point. However, it has been found that the method of analysis for sulphur was faulty and that the more recent method, now in common use in agricultural laboratories, shows a much greater quantity of sulphur present in plants than was heretofore supposed to exist. In fact, the error in the old method of analysis was such that on an average not more than 10% of the sulphur in the plant was recovered, 90% being lost by volatilization. Greater errors than this have been checked against the old method. It is found by comparing the two methods of analysis that plants or portions of plants may show 200 times as much sulphur with the new method as compared with the old. Therefore, the new method of analysis has brought sulphur into prominence as an element of plant-food, indicating that it actually exists in plants in amounts greater, even, than phosphorus. Instead of being an element of minor importance it is now looked upon as an element of the greatest importance.

Experiments to determine the value of sulphur as a plant-food when added to the soil, either as elemental sulphur or in the form of a compound, have been carried out to a considerable extent within very recent years. A number of U. S. Experiment Stations, such as those of Wisconsin, New Jersey, Ohio, Kentucky, Iowa, Oregon, and California, have, within the past few years, made some remarkable discoveries as to the beneficial effects of sulphur when added to the soil as elemental sulphur or as sulphuric acid. Certain European experiment stations have also added to the knowledge of the value of sulphur as a plant-food. Probably the most important work so far done on soils that are somewhat similar to the Utah soils, has been reported by the Californian and Oregon experiment stations. Very recently, and practically coincident with the work done by the American Smelting & Refining Co. was the work done by Dr. C. B. Lipman of the University of California. His preliminary experiments, although of a more limited character than those carried out by the American Smelting & Refining Co., at its Salt Lake experiment station, gave the first valuable hint as to the beneficial effects of sulphur and sulphuric acid on alkaline soils. His more extensive field experiments have not as yet been reported, but information received from Dr. Lipman shows that the results secured under field-conditions are even more striking than the preliminary pot experiments. Quoting from an important bulletin of the Iowa Agricultural Experiment Station entitled 'Sulphofication in Soils,' by P. E. Brown and E. H. Kellogg: "It is known that sulphur occurs in soils mainly in complex organic compounds, only small amounts of sulphites, sulphates, and sulphides and other mineral sulphur compounds being present. It is likewise known that plants require sulphur in the form of sulphates, and hence it is evident that the process of the transformation of organic sulphur compounds into sulphates is of great importance from the standpoint of the feeding of crops. This transformation or oxidation has been termed sulphofication by Lipman in his admirable scheme of nomenclature for bacteriological processes in the soil, and it will be employed in this work as a general term to include the oxidation of organic sulphur compounds, sulphides, and free sulphur with the production of sulphates." Without going into detail, it may be stated that there are two large groups of organisms which have been described as the red or purple bacteria (Rhodobacteriaceae) and the sulphur bacteria or colorless group (Thiobacteriaceae). It is these organisms that bring about the oxidation of sulphur to sulphates, in which form the sulphur is available to plants. That these bacteria are of importance has been shown by the lack of sulphofication of sulphur in soils that have been sterilized by heating, this heating process having caused the death of the organisms. A certain amount of oxidation may take place without the aid of soil-bacteria, but this is of very little importance in the economy of plant life in its relation to the soils. The presence of organic matter in the soil is of importance in determining the bacterial flora. Soils with low organic-matter content are found to have relatively few bacteria, therefore such soils would not be greatly benefited by treatment with elemental sulphur as compared with sulphuric acid.

During 1914 and 1915 the American Smelting & Re-

fining Co., on its Utah experimental farm, made a long series of experiments on the effects of sulphur dioxide on soils and on plant-growth. It was shown, for instance: (1) that the water-solubility of the alkali was lowered; (2) that there was a reduction in carbonate; (3) that there was an increase in sulphate; (4) that there was an increase in available potash; (5) that crops fumigated daily throughout their period of growth with sulphur dioxide in concentrations just below the toxic limit, that is, without visible injury to the foliage, showed either a slight gain, or at least no loss in total vegetal matter produced, as compared with check-plots grown under identical conditions but not treated with sulphur dioxide; (6) that the sulphur content of the plants was increased when treated with SO_2; (7) that in general the sulphur content of plants is an index of the protein content, that is, high sulphur indicates high protein; low sulphur indicates low protein.

These experiments were carried out with plants grown under normal field conditions of cultivation and irrigation. In general, they were treated just as the regular farm crops on the farm were treated. Therefore, the experiment was in no wise of the laboratory type. As pointed out, the sulphur dioxide, under the conditions of application, did not reduce the yield but rather increased it. Upon analysis of the various plants it was shown that there was an increase in the protein content of the fumigated crops as compared with the untreated check-plants. These important findings were accounted for first, by virtue of the direct effect of the sulphur dioxide on the soil; and second, because of the stimulating effect of the sulphur dioxide on the plants; since it was found that both the soil and the plants readily absorbed sulphur dioxide. These experiments were continued during the year 1916, and the results fully corroborated the work done in 1914 and 1915.

In addition to the experiments with sulphur dioxide gas, field experiments of a somewhat pretentious nature were carried out with elemental sulphur and sulphuric acid during 1916. Summarizing these experiments with sulphur and sulphuric acid it may be said that a very uniform tract of land was selected for the experiments and was divided into three equal parts. The chemical and physical characteristics of the entire tract were extensively uniform. One-third of the tract was treated with elemental sulphur which was carefully spread over the surface at the rate of 400 lb. per acre, and was then harrowed into the soil. Another third was treated with sulphuric acid, 46° Baumé, at the rate of 2172 lb. per acre, this acid having a sulphur equivalent of 400 lb. of elemental sulphur per acre. The other third was allowed to remain untreated as a check. The three tracts were plowed, and the sulphur and sulphuric acid added to the respective tracts on April 18, 1916. All subsequent irrigations and cultivations for all three plots, considering the various crops, were identical, both as to time of application, and amount of water, and the time of cultivation, the purpose being to check out every other factor that might enter into the development of the crops. The accompanying tabulation indicates the number of crops utilized in the experiment and the results that were obtained.

INCREASE IN CROP YIELDS FROM TREATMENT WITH SULPHUR AND SULPHURIC ACID COMPARED WITH UNTREATED SOILS

Crop	Planted	Harvested	Per cent gain: Sulphur treatment	Per cent gain: Sulphuric acid treatment
Alfalfa	Apr. 20	8- 7-16	36.8	8.5
Barley	" 20	8- 7-16	52.6	8.6
Beets (sugar)	" 20	9-28-16	3.7	2.1
Corn	May 17	9-16-16	13.1	20.3
Kaffir corn	Apr. 20	9-30-16	43.9	58.9
Millet	" 20	8-12-16	41.4	66.6
Milo maize	" 20	9-30-16	182.6	172.6
Oats	" 20	8-11-16	57.3	72.9
Peas (Canadian field)	" 20	7-26-16	383.3	95.1
Potatoes	May 17	10- 4-16	63.0	2.2
Squash (Utah giant)	" 17	9-22-16	152.7	59.5
Squash (Hubbard)	" 17	9-22-16	187.9	42.4
Sudan grass	Apr. 20	9-30-16	23.9	18.1
Turnips	" 20	7-26-16	10.4	50.4
Wheat	" 20	8- 7-16	127.8	80.6

The accompanying photographs reveal in a most striking manner the results accomplished by treating soils with sulphur and with sulphuric acid. The general superiority of sulphur as a fertilizer stands out prominently. Cut No. 1 shows the effect of a plot treated with 400 lb. of elemental sulphur per acre. The luxuriance of the growth as compared with that shown in No. 2 and No. 3 is most convincing. No. 1 is a similar crop of squash grown on soil treated with sulphuric acid, 46° Baumé, at the rate of 2172 lb. per acre, this being the equivalent in sulphur-content of 400 lb. per acre. No. 3 shows a parallel plot which has received no special treatment. Cut No. 4 reveals the effect of treating the soil with sulphur at the rate of 400 lb. per acre, showing, from left to right, corn, sorghum, millet, Sudan grass, oats, alfalfa, and squash. The corn is over 6 ft. high, the sorghum not yet headed, the millet 3½ ft. high, and the Sudan grass between 5 and 6 ft. high. Cut No. 5 shows similar growths in the same order, grown on soil treated with 46° Baumé sulphuric acid at the rate of 2172 lb. per acre. Cut No. 6 is a check-plot showing similar crops grown on untreated soil. The corresponding yields are given in the foregoing table.

It will be noted that in general the plots treated with sulphur showed a greater gain in total vegetal matter produced than those treated with sulphuric acid. There are, of course, some exceptions, but in general the elemental sulphur produced the best results in the majority of crops. As indicated above, sulphur was applied to the soil at the rate of 400 lb. per acre and the sulphuric acid was applied at a rate sufficient to give the same sulphur equivalent. This is at the rate of about 45 grammes per square metre and indicates, in comparison with several experiments that have been made elsewhere, a maximum application in some instances and a minimum application in others. It may be stated that

our experiments, although carried out under field conditions, were in the nature of preliminary tests. We did not attempt to determine the lower or upper limits of sulphur which would produce maximum results in crop yields. This has been left for further experiments on various soil-types containing varying percentages of alkali and soil-moisture. These experiments are now under way and will be completed during the year 1917, when it is hoped that more definite statements may be made as to the proper amount of sulphuric acid or sulphur to be used in producing maximum results on Utah soils.

In conclusion it may be stated that analyses of the soil of the three divisions into which the field was separated showed: (1) that the water-solubility of the alkali was reduced about 20% in soils treated with sulphur and sulphuric acid as compared with the untreated soils in check-plots; (2) that the availability of potash in the sulphur and sulphuric acid-treated soils was increased approximately 20% as compared with the untreated check-plots; (3) that sulphur and sulphuric acid-treated soils showed an increase of sulphate; (4) that sulphur and sulphuric acid-treated soils showed a decrease in carbonate; (5) that sulphur and sulphuric acid-treated soils increased the yields of all crops with which experiments were made; (6) that sulphur and sulphuric acid-treated soils produced crops with a higher protein-content.

A large number of soil-samples were taken from all three divisions so as to reduce the possible error, and it was found that there was no determinable difference between the effects on the soils treated with sulphur and those treated with sulphuric acid. Aside from the important matter of rendering available more of the potash, the lowering of the water-solubility of the alkali is of importance. The fact that soils having a water-soluble alkali-content somewhat above the limit for general agricultural purposes may be brought under cultivation by treatment with sulphur or sulphuric acid, means that vast areas of now useless lands may be profitably farmed, and that an outlet will be found for the excess sulphur thrown out by smelters as a useless by-product because there has been no sufficient market for it.

The important point which all of the above experiments emphasize, is that sulphur, whether it be in the elemental form, in the form of a gas such as sulphur di-oxide, or in the form of a liquid as sulphuric acid, if applied, even in considerable amounts, to alkaline soils not only does not injure the soils but acts in a very bene-

ficial way. By inspecting the table given above it will be noted that the increase in the yield in certain crops has been enormous where soils were treated with sulphuric acid and sulphur as compared with the untreated check-plots. While the figures as presented seem almost unbelievable, results secured by other experimenters have been even better. Work done in Oregon by the Southern Oregon substation of the Oregon Agricultural Experiment Station has indicated that yields of alfalfa may be increased up to 500% by the use of sulphur compounds. Many other experimenters have produced greatly increased yields in various farm crops through the use of sulphur and sulphur compounds, so that the value of sulphur as a most important fertilizer is no longer doubted. It is known that large quantities of sulphur are taken from the soil each year by crops, and also that a considerable amount is lost through drainage. It is, therefore, evident that in time the soils become deficient in sulphur. We know that analyses of precipitation taken throughout the various parts of the United States, far removed from the vicinity of smelters, indicate that certain amounts of sulphur are carried down into the soil from the air. However, this amount is small in proportion to the amount used by the plants and that which would be lost through drainage. Hence the necessity of making up the deficiency by the application of fertilizer containing sulphur compounds, or by the direct addition of sulphur or sulphuric acid.

COPPER SULPHATE, obtainable as a smelter waste, has been shown by C. B. Lipman, of the California Agricultural Experiment Station, to possess a remarkably advantageous effect in promoting the nitrification of soils, and the consequent stimulation of plant growth. The nitrification increases from 33 to 100% above that in un-treated soils. Copper produces no toxic effect when present in amounts not exceeding 0.1%, and for many plants much larger quantities may be used. Zinc sulphate is also stimulating, but is more likely to exert a toxic influence.

Finding Logarithms

Have you ever been out in the woods away from a table of logarithms and 'up against it' simply because you didn't have any logarithms to work with? If so, this rough method from *Coal Age* for finding approximate logarithms will doubtless be of interest. It is simple and easily remembered.

Lay off axes *AC* and *BC* at right angles to each other. From the intersection lay off 9 equal spaces to the left, as shown, and mark them 1, 2, 3, ... 10, from left to right. Then lay off 10 equal spaces upward from the intersection, as shown, and mark them 0.1, 0.2, 0.3, etc. Then, with the extremes *A* and *B* as centres, and the distance *AB* as a radius, find the centre *D*. From that centre describe the arc *AB*. We are now ready to read off the approximate logarithms. For example, what is the logarithm of 4? The dotted line shows how it is found. It is just a hair more than 0.6. Anyone familiar with logarithms will now understand the rest. It is more convenient, of course, to make the drawing on coordinate paper, but if this is not handy one can easily do without it and employ plain paper. This method is not claimed to be better than a logarithm table, nor as good, but as a means for obtaining approximate results it will be found to be very close to those tabulated. Best of all is its simplicity and the ease with which it can be remembered. After doing it once it will never be forgotten.

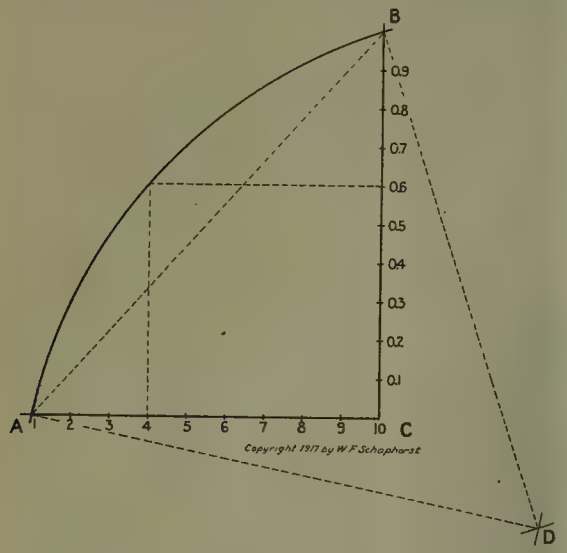

DIAGRAM FOR FINDING LOGARITHMS

MICHIGAN COPPER AND SILVER IN 1916. The production of copper in Michigan in 1916, reported by the U. S. Geological Survey, was 273,692,525 lb., valued at $67,328,361, and that of silver was 716,640 oz., valued at $471,549. This is an increase of $21,078,251, or 45% over the value of the output in 1915. The average price received for copper for 1916 was 24.6c. per lb., compared with 17.5c. in 1915. The average price of silver for 1916 was 65.8c. per oz. and for 1915 it was 50.7c. The average value per ton of ore treated was $5.34, compared with $3.76 in 1915. The smelter production, or the output of refined copper, in 1916 was 269,794,531 lb., which represents an increase of 30,838,121 lb. over the smelter production for 1915. In 1916 the amount of ore milled was 12,364,114 short tons which yielded 420.551,291 lb. of 'mineral' and 268,279,876 lb. copper. In 1915 the amount milled was 12,334,700 short tons, which yielded 400,178,132 lb. of 'mineral' and 265,283,378 lb. of copper. The average recovery of refined copper per ton of ore milled in 1916 was 21.7 lb., compared with 21.5 lb. in 1915.

Production of Rare Metals in Japan

The following figures give the output of rare metal ores in Japan as officially estimated for 1916, and the estimated exports:

Ores	1916	
Output:	Pounds	Value
Antimony	27,333,333	$7,726,750
Molybdenum	74,167	29,910
Tin	562,666	226,818
Tungsten	1,358,333	747,750
Exports:		
Antimony	19,978,643	4,724,049
Tungsten	1,194,933	417,132

Percentages of metal in the ores are: molybdenum, average 40% (superior 60%); tin, average 40% (superior 78%); antimony, average 60% (superior 71%); tungsten, average 60 to 65% (superior 78%).

THE ELECTROLYTIC ZINC CO. of Australia, Ltd., has begun the erection of a zinc plant at Risdon near Hobart, Australia. It will have a daily capacity of 10 tons of zinc, the works being designed with a view to an increase to a daily output of 100 tons. The plant was erected at Risdon owing to the availability of cheap electric power. The company has a contract with the State hydro-electric department for 4000 hp. per annum, effective January 1, 1918, by which time it is hoped that the works can be started. Arrangements for 46,000 electric horse-power have been made by the company. This electrolytic reduction plant is being built in accordance with the plans used by the Anaconda Copper Mining Co. at its Great Falls zinc works. Construction is in charge of American engineers formerly in the employ of that company, and contracts for machinery and supplies were placed in the United States with the exception of the electric equipment which is being built in England on license from the British government, and will be delivered sooner than would have been possible if contracted with American firms. The cost of the 10-ton plant will be about $500,000, since the company, in addition to the reduction-plant, is building a private jetty and a tramway for the transport of concentrate from the Broken Hill mines of New South Wales.

The Miami Appeal

Majority Opinion of the U. S. Circuit Court of Appeals, Philadelphia

WOOLLEY, Circuit Judge:

These are appeals from a decree of the District Court in an action brought by Minerals Separation, Limited, a corporation of Great Britain, against the Miami Copper Company, a corporation of Delaware, charging infringement of United States Letters Patent No. 835,120, issued to Sulman, Picard and Ballot, November 6, 1906; No. 962,678, issued to Sulman, Greenway and Higgins, June 28, 1910, and No. 1,099,699, issued to H. Greenway, June 9, 1914, and owned by the plaintiff.

Of the claims in suit the Court found Claims 1 and 12 of the first patent valid and infringed, and Claim 9 invalid; Claims 1, 2, 5 and 6 of the second patent valid and infringed; and Claims 1 to 12 of the third patent invalid. The decree being in parts adverse to both parties, both appealed, presenting for review the same claims, excepting Claim 9 of Patent No. 835,120, with respect to which the appeal is abandoned.

As both parties are appellants, we shall speak of them as they stood in the Court below.

The three patents in suit, to which we shall refer in the order of their issue as first, second and third, are for processes relating to water concentration of ores. They have for their object, stated generally, the separation of metalliferous matter from gangue or barren matter in ore pulp, by means of oils, fatty acids or other substances which have a preferential affinity for metal over gangue. The first patent, while employing the known selective affinity of oil for metal, is based upon a discovery that that affinity is greatest and metal recovery highest when the proportion of oil to ore is relatively least, and upon the disclosure that that property or characteristic may be brought into action and commercially utilized by agitating the ore-bearing pulp until a foam or froth arises to the surface, carrying with it and holding for recovery the extracted metal.

The process of the second patent is distinguished from the process of the first in that the frothing agent is soluble and develops in solution (when agitated to a froth) a selective affinity for metal similar to that of oil, the insoluble frothing agent of the first agent.

The characteristic of the process of the third patent is that concentration may be effected in the cold and without the aid of acid by the admixture of an aromatic hydroxy compound such as phenol or cresol in the place of the insoluble and soluble frothing agents of the other patents and by agitation of the pulp to a froth.

We are aware that this very brief statement of the distinguishing features of the three patents is technically inadequate and will be understood only by those familiar with the history and development of the art of ore concentration. As that art has been extensively considered and elaborately discussed by scientists and courts both in this country and abroad, in cases in which the invention in suit was involved,* we shall not make even a summary of the art or rehearse the history of this litigation as it has progressed in widely separated parts of the world, but shall rather adopt the whole litigious literature of the invention as matter preliminary to the consideration of the particular issues in this case, repeating only so much as may be necessary to throw light on this new chapter.

FIRST PATENT

The invention of the first patent in suit is based upon a discovery of a wholly unexplained phenomenon arising from the agitation of ore pulp containing oil and air in certain proportions. This was a discovery in an art in which it was well known that the elements of oil, air and agitation possessed certain characteristics and produced certain results.

Haynes, in British Patent No. 488 of 1860, first suggested the use of oil in water concentration of ores by pointing out the affinity which oils have for metallic substances in preference to gangue. Carrie J. Everson showed by Letters Patent No. 348,157, that a small quantity of acid in the pulp aids oil in distinguishing between metal and barren material with which it comes in contact. Elmore (Letters Patent No. 676,679), Kirby (Letters Patent No. 809,959), Froment (British Patent No. 12,778 of 1902), Cattermole (Letters Patent No. 763,260), Sulman and Picard (Letters Patent No. 793,808), and others, employed the known affinity of oil for metal in ore concentration processes by using oil in proportions varying from 2% to 300% on the ore and recovering the oil-coated metal particles by causing them to rise to the top or sink to the bottom of the pulp.

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*British Ore Concentration Syndicate, Ltd., v. Minerals Separation, Ltd., 25 R. P. C., 741, High Court of Justice, Chancery Division; affirmed after intermediate reversal in the Court of Appeals by the House of Lords in 1909.

Minerals Separation, Ltd., v. British Ore Concentration Syndicate, Ltd., 27 R. P. C., 33.

Ore Concentration Company, Ltd., v. Sulphide Corporation, Ltd., Supreme Court, New South Wales, 31 R. P. C., 216, 217.

Ore Concentration Company, Ltd., v. Sulphide Corporation, Ltd., 31 R. P. C., 206, Privy Council, British Empire.

Minerals Separation, Ltd., v. Hyde, 207 Fed., 956 (D. C. Montana).

Hyde v. Minerals Separation, Ltd., 214 Fed., 100 (C. C. A., 9th Circuit).

Minerals Separation, Ltd., v. Hyde.

Minerals Separation, Ltd., v. Miami Copper Co., 237 Fed., 609 (D. C. Delaware).

Agitation of oil-impregnated pulp was old in the art. It was employed by Haynes, Everson, Cattermole, Froment, and Sulman and Picard. In these processes, agitation was either gentle or thorough, but never great, and while always employed to produce a thorough oiling of the metal, it was used in different degrees for the sole purpose of causing the metal particles to rise or sink.

Air and other gases were also known and were developed in the form of bubbles to supplement the natural buoyancy of oil and to assist the oil-coated particles to the surface. This use of air was disclosed by Froment in 1902 and again by students of the University of California, in the California Journal of Technology, in 1903, and by Sulman and Picard in the patent referred to (No. 793,808), commonly called the Bubbles Patent.

Thus it may be stated generally that in the prior art, oil was used for its known selective affinity for metal, agitation to mix the oil with the metal, and air to supplement the buoyancy of the oil in raising oil-coated metal particles to the surface. To this extent had the art of oil flotation advanced when the patentees entered it, having reached the commercial stage in only two processes, Elmore and Cattermole, representing respectively metal-flotation and metal-sinking processes, and having reached the stage of success in none.

The Elmore process was known as the bulk-oil or oil-buoyancy process. It required from 100% to 300% of oil on the ore, that is, from 2000 to 6000 pounds of oil to 2000 pounds of ore, and called for a gentle movement or agitation of pulp in a way that would bring the oil and metal in contact without breaking the oil bulk, and relied for metal recoveries on the buoyancy of the oil (due to the lesser specific gravity of the large volume) to raise and hold on the surface the metal which by affinity it had extracted from the ore. This was an oil-flotation process. It was not successful because the cost of the considerable quantity of oil used and not recovered made its practice commercially prohibitive.

The Cattermole process was just the reverse of Elmore. While this process depended upon the utilization of the same selective affinity of oil for metal, the quantity of oil was relatively small, being from 3 to 6% on the ore; but the agitation was considerable, having for its object not the retention of the oil in bulk as in Elmore, but its separation and thorough distribution through the pulp, with the object and result of causing the metal particles to be brought together and agglutinated with the metal slimes, forming granules of a size and specific gravity sufficient to cause them to sink, where they were recovered while the gangue was carried off the surface by an up-flow. This was the metal-sinking process. It had a doubtful success in the concentration of copper and zinc ores of high metal content, but like the Elmore process it was impracticable because unprofitable for the concentration of ores of medium and low grades.

It was while the patentees were engaged in developing this process with a mechanical appliance known as a Gabbett Mixer, by which the pulp was agitated, that the discovery of the first patent was made. It was found that when the proportion of oil was reduced below 2% the agglutination of Cattermole ceased, and metal recoveries ceased also. This so disturbed the theory upon which the patentees were working that they at once embarked on a series of experiments, in which the quantity of oil was progressively reduced from the Cattermole proportion and the agitation varied in intensity and duration. In experiments with oil in proportions just under the Cattermole proportion nothing resulted. The Cattermole concentration was lost and no other concentration was obtained. When in the line of experiments the proportion of oil to ore was reduced to 1.5%, a "float" appeared. At 1.04% "still more float" appeared. At 0.32% the "float vastly increased." At 0.1% the float again "vastly increased." It thus developed that in using oil at 0.1% or even at 0.05% on the ore, and after violently agitating the pulp from two and one-half to ten minutes, there arose to the surface when the pulp was brought to rest a thick froth or foam of oil-coated air bubbles carrying oil-coated metal particles to the extent of about 90% of the metal content, the form being sufficiently stable to permit removal and metal recoveries.

This was an entirely new result based upon a phenomenon then unknown and still unexplained. It constituted discovery. It was a discovery that promised what has since been accomplished—a change in the art of oil flotation from laboratory experiments and mill failures to commercial success. Its great value, especially in zinc and copper ore concentration, met with world-wide recognition. The art immediately adopted it and paid tribute to it, either by yielding to the patents covering it or by challenging them in litigation commensurate in scope and importance with the field of the discovery itself. The grounds upon which the validity of the patents was attacked were, first, that the phenomenon was already known, and second, that the patents disclosed no novel means for reducing it to practical use. With the decision of the Supreme Court sustaining the validity of the patent, the two grounds of attack disappeared, leaving open, however, the question whether the discoverers have wholly covered their discovery by a patent, and if not, then how far have they appropriated it to their exclusive use, within the principle that in its naked sense a discovery is not patentable and can be embraced in and controlled by a patent only when and to the extent that its principle is developed into invention by the disclosure of a medium or means which brings it into practical use. *Morton* v. *New York Eye Infirmary*, 5 Blatchf., 115.

The particular medium by which and through which the discoverers brought into practical action and put to practical use the principle of their discovery, is a process disclosed in their patent. The process described by the claims in suit, including the elements we have numbered and the distinguishing features we have italicized, is as follows:

"1. The herein-described process of concentrating

ores which consists (1) in mixing the powdered ore with water, (2) adding a small proportion of an oil liquid having a preferential affinity for metalliferous matter (amounting to a fraction of one per cent on the ore), (3) *agitating* the mixture *until* the oil-coated mineral matter *forms* into a froth, and (4) separating the froth from the remainder by flotation.

"12. The process of concentrating powdered ore which consists in separating the minerals from gangue (1) by coating the minerals with oil in water containing a fraction of one per cent of oil on the ore, (2) *agitating* the mixture *to cause* the oil-coated mineral *to form* a froth, and (3) separating the froth from the remainder of the mixture."

The claims disclose the process. The specification, as usual, throws light upon the process by distinguishing it from the prior art, describing its operation and result, and referring to illustrations of its practice in two apparatus, in one of which agitation and consequent aeration and fomentation are accomplished by mechanical means.

The validity of this patent and of its equivalent abroad has been widely attacked and ultimately sustained. As our task is to interpret the scope of the United States patent, we shall concern ourselves only with the decisions of the courts of this country.

The first suit on the patent was brought in the District Court of the United States for the District of Montana (*Minerals Separation, Ltd.* v. *Hyde*, 207 Fed., 956). The validity of the patent was attacked on the ground of anticipation by the prior art, but the Court held the patent valid and found invention in the novel and useful combination of oil, air and agitation (*Minerals Separation, Ltd.*, v. *Hyde*, 207 Fed., 956, 961).

The United States Circuit Court of Appeals for the Ninth Circuit, reversing on appeal the decree of the District Court, found the patent invalid, on the ground that its only novelty lay in the reduced quantity of oil, that this was an improvement only in degree and therefore did not involve invention (*Hyde* v. *Minerals Separation, Ltd.*, 214 U. S., 100).

The case was then removed by certiorari to the Supreme Court of the United States, and while there awaiting hearing, the action at bar was instituted in the District Court of the United States for the District of Delaware (*Minerals Separation, Ltd.*, v. *Miami Copper Co.*, 237 Fed., 609).

In this case the District Court held the patent valid and infringed, finding (in opposition to the Circuit Court of Appeals for the Ninth Circuit) patentable invention in the use of oil in the minute proportion of the patent.

Shortly thereafter the Supreme Court heard argument and entered a decree in *Minerals Separation, Ltd.*, v. *Hyde* by which it reversed the decree of the Circuit Court of Appeals for the Ninth Circuit and held the patent valid, finding invention, as we read the opinion, in the co-action of the critical proportion of oil and air effected by "an agitation greater than and different from that which had been resorted to before," resulting in a froth concentrate of economical value.

Following the decree of the Supreme Court in *Minerals Separation, Ltd.*, v. *Hyde*, this case was argued before us. The decree of the Supreme Court, with its accompanying opinion in the Hyde case, materially changed the aspect of this case on appeal by contracting, and in a sense expanding, the issues as tried by the District Court. It disposed of the issue of validity, which had been vigorously contested in the Court below. But in disposing of that issue upon grounds different from those upon which the District Court based a like judgment, the question of infringement was acutely enlarged. Upon the finding by the District Court that patentable invention resides in the critical proportion of oil, the admitted use of oil in that proportion by the defendant was manifestly controlling in its finding of infringement, although the defense extended to the whole of the defendant's practices. But under the finding by the Supreme Court in the Hyde case that invention resides not alone in the critical proportion of oil but also in air and agitation, we are called upon to construe the patent in the light of that finding and determine whether the defendant's practices of aeration and agitation in connection with its admitted use of the critical proportion of oil, are within or beyond the scope of the patent.

It is to be noted and kept in mind that the Supreme Court did not construe the patent or determine its scope, for it had no occasion to do so. In the case before it, infringement was so clear that it had to be found if the patent was valid. The validity of the patent, therefore, was the only seriously controverted issue before the Supreme Court.

In deciding the issue of validity, the Supreme Court disposed of the prior art as anticipations by reviewing by general classification its processes together with the process of the patent, and in so doing used expressions which the parties have severally employed in support of and in opposition to their respective contentions. The plaintiff maintains that the language of the Supreme Court supports its broad contention, that "Whenever the modifying agent of the patent (oil) is used, a person infringes who gets air into the pulp in any fashion and agitates the mixture by any means to a sufficient extent to cause the mineral particles to attach themselves to air bubbles and to rise therewith above the top of the mixture in a collection of bubbles and metal particles, to wit, froth." The defendant maintains that the agitation in which the Supreme Court found invention, is agitation produced by mechanical means, and that anyone, who, though using the modifying agent of the patent in the critical proportion, introduces air into the pulp otherwise than by beating it in, and who agitates the pulp to a metal-bearing froth by any means other than mechanical, or who otherwise obtains the result without any agitation whatever, is beyond the scope of the patent and escapes infringement.

Considered in the light of what the Supreme Court said and what it did not say, it is clear that the positions

of both parties are extreme. The contention of the plaintiff at least omits the very definite limitation of the patent to the results obtained by the use of oil within the described proportions, and also the equally definite disclosure of an agitation in violence and duration greater than before employed, while the defendant misintrepets words of description as words of limitation.

The Supreme Court said that:

"The process of the patent in suit, *as described and practiced,* consists in the use of an amount of oil which is 'critical' and minute as compared with the amount in prior processes * * * and in so impregnating with air the mass of air and water by agitation—*'by beating the air into the mass'*—as to cause to rise to the surface of the mass, or pulp, a froth particularly coherent and consistent in character * * *."

By this expression the defendant maintains that the Supreme Court did not merely repeat testimony describing and showing how the process was practiced, but used the words as their own, and thereby interpreted the patent and limited its scope to the introduction of air into the pulp "by beating the air" into the pulp by the specific mechanical means illustratively shown by the drawings of the patent. We do not so interpret this expression. In the first place, the patent nowhere uses the words "by beating the air into the mass." Therefore these words as quoted by the Supreme Court were not quoted from the patent, but were taken from the testimony of a witness who used them in describing the process as discovered and developed by the patentees. This being so, we do not think these words, as used by the Supreme Court in describing the process, can be construed as a limitation upon the process.

It further appears that the Supreme Court in distinguishing the process of the patent from processes of other patents relied on as anticipations, found that the lifting force which separates metallic particles of the pulp from other substances resides chiefly "in the buoyancy of the air bubbles introduced into the mixture *by an agitation greater than and different from that which had been resorted to before.*" By this expression the defendant insists that the Court explicitly limited the patent to agitation caused by mechanical means, thereby excluding from its scope such agitation by pneumatic means as was used in part in the defendant's practice. As this expression is susceptible of an entirely different meaning, presently to be considered, we find nothing said by the Supreme Court which indicates that it limited the agitation of the patent to agitation by mechanical means.

The defendant further maintains that the Supreme Court gave to the patent a narrow construction when it used these words:

"While we thus find in favor of the validity of the patent, we cannot agree with the District Court in regarding it valid as to all of the claims in suit. As we have pointed out in this opinion, there were many investigators at work in this field to which the process of the patent in suit relates when the patentees came into it, and it was while engaged in study of prior kindred processes that their discovery was made. While the evidence in the case makes it clear that they discovered the final step which converted experiment into solution, turned failure into success (*The Barbed Wire Patent*, 143 U. S., 275), yet the investigations preceding were so informing that this final step was not a long one and the patent must be confined to the results obtained by the use of oil within the proportions often described in the testimony and in the claims of the patent as 'critical proportion' amounting to a fraction of 1% on the ore. * * *"

We are inclined to the opinion that by this expression the Court intended a limitation only upon that one feature of the patent to which the expression was addressed. The District Court had held valid certain claims in which the proportion of oil was described simply as "a small quantity," and the Supreme Court in reversing that finding and holding those claims invalid, used the quoted words of limitation in confining the patent to the results obtained by the use of oil in the critical proportions of less than 1%.

From this recital of the litigation of the invention of the first patent it appears that in construing the claims of the patent we are greatly aided by the opinion of the Supreme Court in being told with authoritative finality that the process involves invention and in being shown in which of its elements invention resides; but it is equally clear that in determining the breadth and scope of the claims, we are without the aid of any adjudication in which their scope has been decided, or even considered.

The elements of the patent in which invention is found are oil, air, and agitation. These were old in the art, possessing in the process of the patent no new or different function, or had they produced no new or different result, it is clear they would have anticipated the patent and defeated its claim to invention. But a finding by the Supreme Court that the invention was not anticipated by the old uses and results of these elements is, in effect, a finding that these elements as used in the process of the patent perform or develop new uses and functions or produce different results. And such we find to be the fact.

The invention, as we have said, is founded upon a discovery. Its patentability depends upon the medium disclosed in the patent by which the force or principle of the discovery is brought into action. Three new uses of old elements are disclosed in the patent, producing a new result. The first relates to oil.

The affinity of oil for metal was known, and though old, was employed in the invention; but that this affinity in a given condition is greatest when its quantity is relatively least or that the affinity increases with the decrease of oil below a given quantity (less than 1%), is the soul of the discovery and was wholly new. But the discovery did not consist of this alone. The newly discovered phenomenon of the minute quantity of oil is not a chemical phenomenon. Oil in pulp in minute quantity, if inert and left alone, will do nothing and produce

nothing. Something must be done to develop it. The phenomenon not being susceptible of development by chemical change, is developed by physical change of the pulp. As a medium or means of producing that change and creating the condition under which the phenomenon arises, the patentees pointed out—agitation.

The agitation of the patent does several things, old and new. It mixes the oil with the metal of the ore. This is old. Then, by its greater intensity and longer duration, it stirs the pulp into a froth, developing at once its own new use as a frothing means, and still another new function of oil—that of a frothing agent. Both are new.

But froth is made of air as well as oil. Air in bubbles is used for its old function of assisting or escorting metal particles to the surface. But it is also used for the entirely novel purpose of supplying one of the essential elements of froth, froth being the new result intended.

Thus, oil is used for its newly discovered characteristics of greater metal affinity when in minute quantity and for its new function as a frothing agent; air for the new purpose of supplying an element of froth; and agitation for its new purpose of bringing the two together and causing them to co-act and produce the new result of a metal-carrying froth. In other words, in so employing these old elements for new purposes, the new things which the patentees told the art that a radical decrease of oil in conjunction with a radical increase of agitation, develops to its highest potentiality the known affinity of oil for metal, and produces a physical change in the pulp in the form of a froth by which metal recoveries are made possible and commercially profitable. The importance of these disclosures, scientifically and commercially, is manifest.

In approaching a consideration of the scope of the patent, we lay aside those features of the discussion in which the plainttiff demands by broad construction the highest reward for a great contribution to a feeble art, and in which the defendant, contending for a narrow construction, emphasizes the servitude of a great art to a patent monopoly. The rights of an inventor and of an art in an invention are established by law and are not affected by other considerations. Speaking generally, the statutes give an inventor a patent monopoly of his invention to the extent of his patent disclosures, and to that extent the art is servient to his monopoly. Everything touching the invention not disclosed by the patent is free to the art without regard to the value of the inventor's contribution. So the question of law in this case, involving as it does large interests and perhaps far-reaching commercial results, is no different from similar questions constantly appearing in controversies of smaller compass. The question simply is whether certain practices come within the scope of the patent claims. But the question of infringement has grown far beyond the borders of the case and we are really asked both by the plaintiff and defendant to determine the scope of the patent in such terms as will inform the art as well as the owners of the patent the precise field covered by the patent and the extent of the field left free to the art. Such a decision to be useful must of course be predicated upon facts that make it legally possible, for otherwise we encounter the futility and the mischief of construing a patent in general terms and without reference to the occasion or thing which call for its interpretation. To avoid this error we shall confine ourselves to the precise issues of this case as developed by the evidence, and without regard to other considerations we shall construe the patent with reference to the particular practices which are represented by one party to be within its scope and by the other to be beyond it.

The defendant practiced four processes of ore concentration using in all the fomenting agent of oil in the critical proportion of the patent. Two processes were practiced before suit was instituted, the third during the progress of the trial, and the fourth after the record had been completed and the trial closed. As the infringement found by the decree relates to the processes appearing in the record, only those processes are before us on appeal.

First Process. The defendant company owns and operates a large porphyry copper mine at Miami, Arizona. The ore is low grade and of a kind peculiarly responsive in concentration to the process of the patent.

The defendant employed a metallurgical mining engineer to develop and install in its reduction works an oil-flotation concentration plant. The engineer made repeated visits to the mill of a neighboring copper company, a licensee of the plaintiff, studied the process of the patent there in practice, and reproduced it in the mill of the defendant. This was a small plant, of a capacity of but two tons per hour or forty-eight tons per day, operated during the period from December 1913 to August 5, 1914. It was used evidently more as a testing or experimental plant for another process then being developed for commercial purposes.

This constituted the defendant's first process, and as infringement was not disputed, we affirm without discussion that part of the decree holding infringement by this process.

Second Process. On August 7, 1914, two days after the discontinuance of the first process, the defendant started its second process in a plant which it had constructed during the practice of the first. This plant may best be understood by a diagram furnished by the defendant and by its own detailed description of its operation appearing in its brief.

"The material treated in the flotation plant at Miami, is received through the launder or trough A, the same bearing the legend 'Original Pulp Feed.' This material is a freely flowing pulp, and flows into the box or tank B, upon which the following inscription appears, 'Sump from Which Pulp is Pumped.' The oil or other modifying agent is supplied to the pulp through the pipe L, marked 'oil feed.' A centrifugal pump C raises the pulp from the pipe L, marked 'oil feed.' A centrifugal pump C raises the pulp from the sump B, and forces it

upwards through a pipe D, from which the pulp passes into an inlet funnel E. The pulp flows from the funnel E downward through a pipe F and enters the Pachuca tank G through the side thereof, as shown in the drawing. A small air pipe H, extends downwardly from the top of the Pachuca to a point near the bottom thereof, where it delivers an air jet at the point designated I. The small air pipe H is surrounded by a larger pipe J, open at both ends. There is an annular space between the pipes H and J, and the air entering the lower end of the large pipe J, through the pipe H, permeates the pulp contained in the pipe J with small bubbles, which have the effect of forming a mixture of air and pulp of lower specific gravity than the pulp alone. The lightened column of air and pulp in pipe J rises and is projected against a conical deflector K, and then falls into the main body of the Pachuca. The circulatory movement of the pulp in the Pachuca tank has the effect of thoroughly mixing the oil with the pulp. The pulp flows from the top of the Pachuca tank into a box M, whence it is conducted by the launder or trough N to the air cells, marked 1, 2, 3 and 4.

"The air cells 1, 2, 3 and 4 are similar in construction. The bottom of each cell consists of four plies of canvas, beneath which are eight air compartments, separate and distinct from each other, extending in a series from end to end. The canvas bottom of the machine is inclined, thus making the cell deeper at one end than at the other, and it is for the purpose of getting an even distribution of air that the eight compartments are used, it being obvious that if there were a single air compartment most of the air would escape at the shallow end, where the water pressure is least. Air under slight pressure is supplied to the compartments beneath the cells 1, 2, 3, 4 and 5, by means of a blower designated by the letter M upon the drawing. The air is conducted through a pipe marked 'Air Main' from the blower, and branch air pipes, shown most plainly at the right of cell No. 1, conduct the air to the several compartments beneath the cells. The degree of air pressure necessary is quite slight, and, as stated by Mr. Yerxa, it is necessary to use merely enough pressure to overcome the hydrostatic head of the pulp and to force the air through the permeable medium, that is, the canvas bottom.

"The air so pumped beneath the canvas bottoms of the cells 1, 2, 3, 4 and 5, passes upward through the pores of the canvas into the pulp, and the bubbles rise through the pulp in a manner similar to the rising of the bubbles through a glass of carbonated water."

For the purpose of this discussion, the details of the apparatus and of its operation may be simplified by referring to its four essential parts: C, centrifugal pump; E, a break or open space between the pipe of the pump and the Pachuca tank which does not appear on the diagram or in the defendant's account of the operation; G, Pachuca tank and its appliances; and 1, 2, 3, 4 and 5, Callow cells.

Before following the steps or rather the flow of the defendant's process, we should have in mind the theory of its practice. The defendant maintains that the process of the patent is "an *agitation* froth process," that is, a process by which the desired metal-bearing froth is obtained by agitating pulp containing the critical quantity of the frothing agent (oil) "to cause" the froth to arise or "until" a froth is formed. It says that its process, in contradistinction to the process of the patent, is a "*bubbles* process" (containing the same critical quantity of the same frothing agent), by which air, introduced into the pulp from below, passes through the pulp "without any agitation whatever," and arises to the surface in short-lived evanescent metal-bearing bubbles forming a "*foam.*" It maintains that by introducing air into the pulp by sub-aeration it produces a foam or froth otherwise than by agitation, that nowhere in the process is there agitation, or that, at most, there is only such agitation as appears in the prior art.

Agitation "to cause" a froth or agitation "until" a froth is formed, being the disclosed means of the patent to produce the phenomenon of the critical quantity of oil, and aeration without agitation being the defendant's claimed means of causing or obtaining the same phenomenon from the same critical proportion of oil in the form of an evanescent foam, the controversy revolves around the elements of aeration and agitation.

C. *Centrifugal Pump.* The first step in the defendant's process was a centrifugal pump. The defendant claims its one function was that of lifting the pulp (containing oil in the critical proportion of the patent) from one floor of the mill to another, and that in doing so the pulp was neither agitated nor aerated. Opposed to this contention and to the testimony supporting it was testimony that a centrifugal pump drawing air and liquid was the most common type of agitator and aerator of the cyanide art before the Pachuca tank was invented; that in the defendant's apparatus air was drawn with the liquid into the pump in large quantities; and that in revolving at the rate of 850 revolutions per minute the pulp was violently agitated and measurably aerated.

Reconciling the conflicting testimony as best we may, we are forced to the conclusion that the pump revolving at the rate of 14 revolutions per second could not well avoid agitating the liquid it hoisted; that the agitation was violent; that air was drawn in with the liquid and that to an extent the pulp was aerated within sense of the agitation of the patent and also by the very mechanical means or its equivalent to which the defendant insists the patent is limited.

E. *Break in the Circuit.*—At the point E in the pipe between the pump and the Pachuca tank there was a break not appearing in the diagram, permitting the pulp, arising from the pump in its agitated and partially aerated state, to drop for a space through the air into a larger pipe, whence it was carried to the Pachuca tank. While this was not a prominent feature of the defendant's process it was of sufficient consequence for the defendant to use it. It had the effect of producing further agitation of the pulp in its fall and further aeration arising from that agitation. It was known as

splash agitation, its principle appearing in the early attempts to purify water by aeration. We are satisfied that this constituted agitation and aeration by agitation, and again by mechanical means to which it is sought to limit the patent.

G. *Pachuca Tank.*—The pulp twice agitated and aerated was then carried without stopping into a Pachuca tank. This appliance, briefly described, is a tank 18 feet 6 inches high by 4 feet in diameter. Descending in its centre are two pipes or columns, one within the other, and in operation compressed air is released through the inner one, sending the fluid in an upward current through the outer one until it strikes with force an overhanging cone or umbrella, which causes it to splash and fall back into the tank, to be subjected again and again to the same revolving movement for a period of time measured by minutes.

The Pachuca tank was taken from the cyanide art, where its one function was agitation and aeration, or rather aeration by agitation. Although agitation is denied by the defendant to be a part of its process, it cannot be seriously contended in the face of the testimony and of the demonstration of the action of the Pachuca tank before us, that the force of compressed air to which the pulp in the tank is subjected, does not cause agitation and very violent agitation.

But the defendant contends that the agitation of the patent is limited to agitation occasioned by mechanical means, and as the agitation in the Pachuca tank is caused by pneumatic means, it is beyond the scope of the patent. This contention is based not alone upon the words of the Supreme Court which we have already discussed, but upon the relation of a mechanical device to the discovery of the invention.

It appears that in the experiments in which the discovery was made, the inventors agitated various mixtures by an apparatus known as a Gabbett Mixer, and when they came to reduce their discovery to invention and patent it they illustrated diagrammatically "one form of apparatus suitable for carrying this invention into practice," which included such a mixer. The patentees did not attempt to patent a mechanical means by which their process could be practiced. This is obvious, for the means illustratively shown was a mechanism already patented (No. 444,345, Gabbett Mixer, 1891). Nor did they attempt or intend to limit their patent to any mechanical means. Their patent was for a process. But without regard to their intention, did they in fact so limit it? That depends upon what they disclosed by their patent.

By their disclosures they first told the art that a maximum metal recovery could be had from a minimum oil content. Up to the time of this disclosure that was an unknown phenomenon. But this disclosure alone, interesting as it was, would have been valueless to the art, and would not have entitled the discoverers to a patent, until they told how and by what medium that phenomenon could be brought into practical use. Knowing this, they then told the art by the same disclosures that the minute quantity of oil, besides possessing an affinity for metal, was a frothing agent, and when used as such a phenomenon appeared in the froth it developed. But patentees did not stop with the disclosure that fomentation is the condition out of which the phenomenon arises, but proceeded by further disclosures to tell the art that the way to produce the desired fomentation is by agitating the pulp containing the frothing agent. But agitation of certain kinds for certain purposes was well known, so they went further and told what was not known, namely, that the agitation requisite to fomentation of the character desired, is agitation "greater than and different from that which had been resorted to before," that is, greater than the more or less brisk or vigorous test-tube agitation of early patents and of the Cattermole process, and different from the revolving gentle agitation of the Elmore bulk-oil process, and that it must be violent in character and extended in duration in order that air (the other element of fomentation) might be brought into the fluid and into co-action with the minute quantity of the frothing agent. They thus disclosed not only agitation, but the kind of agitation as the medium or means by which the principle of their discovery could be reduced to practice. Agitation was thus made the practical element of their patented process, and by their patent disclosures they told the art that agitation was the secret by which the principle of their discovery could be unlocked and used.

If the same principle can be turned to use and the same results obtained without agitation, or by an agitation which is not the equivalent of the agitation of the patent disclosures, we may have another question; but when the critical quantity of oil is used and fomentation is produced by agitation, which in degree of violence and in duration is substantially that of the patent, clearly it is indifferent whether it is attained by mechanical or other means, for the patent deals with agitation as a means of developing the discovery, not with means for developing agitation.

Accepting the teaching of the patent with reference to agitation as a means, the defendant employed it, certainly in three, if not in four, of the steps of its process. In the first and second, agitation was obtained by mechanical means; in the third (the Pachuca tank), by pneumatic means. It is upon this difference in means to produce agitation that the defendant, in part, defends the charge of infringement. But what it sought and what it got by the use of the Pachuca tank was agitation, and that is what the patent told it to get, and we conceive it makes no difference whether it got it by mechanical or pneumatic means. We see no difference between the blow of a paddle and the blow of a blast of air as means to produce agitation. And the defendant itself shows there is no difference between the two in procuring the agitation of the patent, for by agitating the pulp in the Pachuca tank by pneumatic means with an intensity and for a period of time sufficient to aerate the pulp, the defendant got the precise metal-bearing froth of the patent. This was unintentionally and ae-

cidentally shown on one occasion when the Pachuca tank was cut out of the process and the pulp brought to rest. The characteristic froth of the patent arose at once and formed in a collar two feet thick. In view of the agitation to which the pulp had been subjected, we must assume that it was the result of that agitation.

Thus far the defendant did everything that is disclosed by the process of the patent. It used the critical quantity of oil. This is admitted. It agitated the pulp by one means and another with an intensity and for a time sufficient to change the physical character of the pulp, as intended by the patent, and developed in it the quality of producing an air-bearing froth, which it did when permitted to come to rest. But in the practice of the defendant, agitation was not stopped or even arrested in the Pachuca tank. The pulp was carried in circuit without stopping and without abatement of agitation into Callow cells, carrying with it the air content accumulated by the agitation of the centrifugal pump, the air drop and the Pachuca tank.

1, 2, 3, 4, 5. *Callow cells.*—As a last step, the pulp was conveyed into Callow cells. A Callow cell is a rectangular bank with a sloping bottom made of canvas, through the perforations of which compressed air ascends in myriads of air bubbles through the liquid it contains. By this process, the defendant contends it pursued a practice taken from the prior art and entirely outside the scope of the patent.

In this connection much stress has been placed by the defendant upon the prior art, on the theory that as the Supreme Court found the invention not anticipated, all that the prior art contains is open to it without the hazard of infringement. This position is unobjectionable. It it clear that if the defendant practiced the process of the patent and obtained a different result, or if it practiced a different process and obtained the same result, it did not infringe. To do this it was free to resort to a practice of the prior art or to a practice new to the art. It chose to rely upon a practice of the prior art, which, though producing the same result in metal recoveries as that of the patent, it maintains, differed from it in its steps and means. It was based upon Patent No. 793,808 granted to Sulman and Picard (two of the patentees of the patent in suit), and commonly called the Bubbles patent. This patent, though it never reached the mill, has been extensively discussed by experts and counsel. Air is introduced into the bottom of a tank similar in shape to that of a Callow cell. Near the bottom is a perforated helical worm or tube, through which, while revolving, air is permitted to escape and ascend in bubbles to the surface. As the pulp is modified by oil (not the critical quantity of the patent) the air bubbles and metal particles are coated with oil, whereupon the oil performs its known affinity for metal, and air its known characteristic to ascend and assist the oiled metal to the surface.

While there is a similarity in principle between the mere introduction of air in the Callow cell and in the Bubbles tank, the purpose for which air is injected and the function which air performs after it is injected are altogether different in the two. Before the pulp is put into the Bubbles tank it is agitated for the purpose of mixing the oil and coating the metal particles, and when that is done it is turned into the Bubbles tank where the air bubbles, liberated through the perforations of the coil, attach themselves to and escort the oil-coated metal particles to the surface, where they are carried off by skim flotation. In the Callow cell of the defendant's process (the claimed equivalent of the Bubbles tank) air was used for another purpose. The pulp, first agitated to the potentiality of the critical quantity of oil and air of the patent, was carried into the Callow cell, and with its elements thus fully developed was subjected to an air blast, which did two things, resulting in a third. First, the air blast further aerated or super-aerated an already fully aerated pulp by driving into it myriads of air bubbles, and second, caused an agitation which while considerable was not violent, resulting in a foam, which persisted so long as air pressure was maintained, and which had a metal-bearing quality and sufficient stability to permit recovery by overflow.

A peculiar feature of this step in the process and upon which the defendant earnestly relies to distinguish it from that of the patent, is, that if the pulp agitation of the Callow cell is arrested by withdrawing the air pressure, the foam immediately subsides and the froth of the patent does not arise as it did when agitation was arrested in the Pachuca tank. This is true. It is equally true that in this fourth step, aeration is direct and is not the result of or caused by agitation. On the contrary, agitation results from aeration, and such agitation, though present in some measure, is not even approximately of the violence and duration of the agitation of the patent. The operation in the Callow cell certainly possesses these distinguishing features from operation of the process where aeration is caused by agitation. Emphasizing this difference in its favor, the defendant pressed further and urged that the operation of the Callow cell was not dependent upon the precedent treatment of pulp in the Pachuca tank, and that the same results could be obtained from the Callow cell without such previous agitation and aeration. This assertion is based upon an experiment made by the defendant in the presence of representatives of the plaintiff when the Pachuca tank was cut out of the system and pulp from the centrifugal pump was shunted directly into the Callow cells, with the result that the Callow cells continued to perform their function of supplying air bubbles, agitating the pulp to a degree and forming an overflowing metal-carrying foam. But the metal carried over was not assayed and we do not know what were the commercial results of the test. We know, however, that this was but an experiment and after the experiment had been concluded, the defendant returned immediately to its practice of using the Pachuca tank. Nor are we informed as to what would happen if the centrifugal pump had also been cut out, because whether in the mill or in the laboratory, so far as we have been

shown, it appears that *before* the Callow cell (or Bubbles tank) is called upon to perform its task, the pulp is always pre-agitated and pre-aerated in some fashion and to some extent. Even in the demonstrations of the Callow cell and the Bubbles tank made before us in court, the defendant's demonstrator caused the pulp to be violently agitated by a *Gabbett mixer,* the illustrated means of the patent, for a period of time measured by a stop-watch before it was turned into the cell and tank.

Notwithstanding the defendant's testimony is silent as to what a Callow cell would do to pulp that had not been previously agitated and aerated, and notwithstanding all Callow cell demonstrations before us were made with pre-agitated and pre-aerated pulp, the case for the defendant was largely argued as though its process consisted solely in passing thoroughly mixed but quiescent pulp directly into Callow cells, where it received its first and final aeration without previous or present agitation, resulting in a metal-bearing foam with characteristics different from those of the froth of the patent. We find nothing in the evidence or in the demonstrations which justifies that argument. If the only agitation to which the pulp was subjected (after such agitation as in the prior art was necessary to mix the oil and ore) was the agitation of the Callow cells, we would not say that that agitation amounted to or was the equivalent of the violent agitation of the patent disclosure and constituted infringement; but in the process we are considering and upon which the decree we are reviewing was based, the Callow cells were not the whole process but were merely the last of four distinct parts of the process, the other three being the process of the patent or its fair equivalent. Having used the process of the patent in the first three steps in developing in the pulp the potentiality of the critical quantity of oil and air and in bringing the pulp to the point where, if permitted, it would produce the result of the patent, we feel that the defendant cannot escape infringement by taking an additional step, even though that step if taken alone avoids the patent.

Third Process. The third process of the defendant was developed and put into practice during the trial and constituted one of the defenses to the charge of infringement. There is little difference between it and the second process. It is shown by the accompanying reproduction of a blueprint of the apparatus in which it was practiced.

The plant is shown to comprise two independent sets of flotation cells, one at the right and the other at the left of the drawing. The flotation cells are designated—"4—Roughing Cells" and "2—Cleaner Cells." Adjoining each group of cells is a Pachuca tank. The operation begins upon the 22 concentrating tables, so numbered upon the drawing. The material rejected by these tables is treated by the flotation process. The flow of pulp in the tables through the launders takes place by gravity until the pulp reaches a bucket elevator, which is the substitute for the centrifugal pump in the second process. When the pulp is raised by the elevator to an upper floor it is divided and flows in equal parts into two Pachuca tanks, thence to the Callow cells, where metal recoveries are obtained by froth overflow.

The value of this process, as a defense, is found in an experiment to which it was subjected. The plant was arranged in two groups of identical members. In the experiment, one group was operated with the Pachuca tank as planned. In the other, the Pachuca tank was cut out and the pulp conveyed directly from the elevator to the cells. The result was no apparent difference in the action of the pulp and little difference in the assays of the metal recoveries, that difference, curiously enough, being in favor of the group in which the Pachuca tank was not used. The evidence of the fact and of the effect of this experiment was not contradicted, except, perhaps, by the defendant itself, by returning at once to its previous practice of using both Pachuca tanks, and in pursuing that practice to a time beyond the trial. This fact places the third process in the position of the second, where we have found that agitation and aeration of the Pachuca tank is the agitation of the patent, and amounts to infringement.

Fourth Process. The fourth process is not in the record and was not considered by the District Court in reaching the decree now before us on appeal. It was brought to our attention during the argument by counsel, who said that in the process developed by the defendant after the trial, and now practiced, the Pachuca tanks are eliminated, the pulp being delivered directly from the bucket elevators to the Callow cells. While we are loath to omit from our consideration and judgment anything affecting this very important patent and the art to which it relates, we feel, nevertheless, that we cannot consider and adjudge with propriety or authority a process with respect to which the plaintiff has had no opportunity to produce testimony and which was not embraced in the decree we are reviewing.

We find no error in the decree of the District Court holding valid and infringed Claims 1 and 12 of the first patent in suit.

Second Patent

The second patent involved in this suit, No. 962,678,—also for improvements in ore concentration—was applied for on April 30, 1909, was issued on June 28, 1910, to Sulman, Greenway and Higgins, and has not been judicially passed upon except by the Court below. Its particular object is "to separate to certain constituents of an ore such as metallic sulphide from other constituents, such as gangue, when the ore is suspended in a liquid such as water."

It is also an air-froth flotation process but differs from the first patent although both processes may be, and both actually are, employed conjointly. Its essential feature is the use of a mineral-frothing agent in solution, and the method will be best understood by turning to the specification:

"According to this invention the crushed ore is mixed with water containing in solution a small percentage of a

mineral-frothing agent (that is of one or more organic substances which enable metallic sulphide to float under conditions hereinafter specified) and containing also a small percentage of a suitable acid such as sulphuric acid, and the mixture is thoroughly agitated; a gas is liberated in, generated in, or effectively introduced into the mixture and the ore particles come in contact with the gas and the result is that metallic sulphide particles float to the surface in the form of a froth or scum, and can thereafter be separated by any well-known means. Among the organic substances which in solution we have found suitable for use as mineral-frothing agents with certain ores are amyl acetate and other esters; phenol and its homologues; benzoic, valerianic and lactic acids; acetones and other ketones such as camphor. In some cases a mixture of two such mineral-frothing agents gives a better result than a single agent. The above mentioned mineral-frothing agents are all more or less effective in the presence of an acid such as sulphuric acid and are given as types but are not intended to form an exhaustive list of suitable organic substances which may be used in this manner and for these objects. On the other hand, there are many organic compounds which in solution will not effect the result described, such as some sugars, dextrin, saponin, albumen, ox gall, etc., and a simple test is required in the case of varying ores or materials to determine which organic compound is most suitable.

"The following is an example of one method of carrying this invention into effect: Water containing a small percentage of sulphuric acid in solution, say from 0.2% to 0.5%, and containing in solution a small quantity, say 0.1% of one of the foregoing organic substances (say amyl acetate) is, with finely pulverized ore, introduced into an agitating apparatus, in the proportion of say 3 parts by weight of water to 1 part by weight of ore. The agitation is carried out in such a way as thoroughly to disseminate air through the mixture which is thereafter discharged into a spitzkasten. It is found that a coherent froth or scum floats on the surface of the water in the spitzkasten. This froth contains a large proportion of the metallic sulphides but is substantially free from gangue. Any well-known means may be employed for collecting the froth. If desired the tailings can be retreated by the same process with or without the addition of fresh quantities of the organic materials referred to. The action may in some instances be improved by heating the mixture.

* * * * * * *

"Several agitation vessels are placed in series. These may be conveniently large vats separated by partitions having openings at the bottom so that the liquid may pass from one to another. Each vessel is provided with a rotatable stirrer which is conveniently of the form shown in the drawing. Each stirrer is carried on a spindle rotated at a high speed by any convenient means. Crushed ore or similar finely divided mineral is fed into the first vessel through any convenient ore-feeding device * * *, and water is also fed into the vessel. A small proportion of acid, such as sulphuric acid, may be introduced into the water from the feeding vessel, and a small proportion of one or more other soluble substances which enable metallic sulphides to be floated by air under the conditions hereafter specified, may be introduced from the feeding vessel. The liquid containing ore in suspension is vigorously agitated in the agitation-vessels and escapes at the outlet highly charged with air.

"A settling apparatus consisting of one or more spitzkasten is placed immediately at the outlet from the agitation apparatus. As shown in the drawing, the spitzkasten has a launder to receive the floating froth which passes away through the outlet. The liquid and the sunken material pass out through the outlet at the bottom of the spitzkasten. The level of the liquid in the spitzkasten is slightly above the lip. Within the spitzkasten is placed an inclined baffle or guide-plate, which may be made adjustable, extending upward from below the inlet and arranged to direct the stream of ore-particles and air-bubbles toward the surface of the liquid in the spitzkasten.

"Hitherto many proposals have been made for the wet concentration of ores involving the addition to the liquid in which the ore is suspended of an immiscible liquid. For example in the patent granted to Cattermole, Sulman & Picard, United States No. 777,274, dated December 13th, 1904, is described a process of ore concentration in which metalliferous particles were coated with a thin film of a fatty or resin acid or a phenol or a cresol by introducing the alkaline compounds of these materials into an acid liquid whereby these materials were liberated in an immiscible or insoluble condition and adhered to the mineral particles. In another known process the powdered ore suspended in water, preferably acidified, is mechanically brought to the surface whereby the particles are exposed to the air and it is found that the metalliferous particles float on the surface while the gangue sinks. In this known process the selective flotation of the metalliferous particles is not due to the metalliferous particles being coated with a selective agent, that is to say, the selective flotation is due to the properties of the metalliferous particles themselves when exposed to air or other gas and brought onto the edge or surface of water preferably acidified.

"The present process differs from the two before mentioned types and from other known concentration processes by the introduction into the acidified ore pulp of a small quantity of a mineral-frothing agent, *i. e.*, an organic compound in solution of the kind above referred to and by the fact that the metalliferous particles are brought to the surface in the form of a froth or scum not by mechanical means, but by the attachment of air or other gas bubbles thereto.

"In the frothing processes hitherto known, the substances used to secure the formation of a mineral-bearing froth has been oil or an oily liquid immiscible with water. According to this invention the mineral-frothing agent consists of an organic compound contained in solution in the acidified water.

"We do not confine ourselves to the proportions above

given; the best proportion can in each case be easily determined by trial.

"It is well known that certain of the organic substances we have referred to are not soluble in water in all proportions and that if used in excess might partly remain insoluble in the acidified water and might become mechanically affixed to the metalliferous particles of the ore. We disclaim any such use of these substances and only claim them in such amount as will enable them to dissolve in the acidified water."

The claims in issue are the following:

"1. The herein described process of concentrating ores which consists in mixing the powdered ore with water containing in solution a small quantity of a mineral-frothing agent, agitating the mixture to form a froth and separating the froth.

"2. The herein described process of concentrating ores, which consists in mixing the powdered ore with water containing in solution a small quantity of an organic mineral-frothing agent, agitating the mixture to form a froth and separating the froth.

"5. The herein described process of concentrating ores which consists in mixing the powdered ore with water containing in solution a small quantity of a mineral-frothing agent, agitating the mixture and beating air into it in a finely divided state so as to form froth and separating the froth.

"6. The herein described process of concentrating ores which consists in mixing the powdered ore with water containing in solution a small quantity of a mineral-frothing agent, agitating the mixture and beating air into it in a finely divided state so as to form froth and separating the froth."

The difference between the two patents may be shortly stated to be this: The first process rests upon the use in very small quantity of an oily substance that does not dissolve in water, coupled with agitation of the pulp, and this succeeds in producing a special froth that is remarkably effective in recovering the minute particles of ore. The second process does not employ oil, or an undissolvable substance; on the contrary, the "mineral-frothing agent" must be in solution, and *ex vi termini* must therefore be dissolvable. The specification disclaims the use of so large a quantity that part of it remains undissolved. The "mineral-frothing agent" is further limited by describing it as "one or more organic substances which enable metallic sulphides to float under conditions hereinafter specified;" and, as this general statement does not convey specific information, the patentees give several examples of organic substances that are found to be suitable for use in solution. In passing, we may note that claims 1 and 5 are broad enough to cover inorganic frothing agents also, but as no such agent is yet known, this feature need not now be considered. Just how or why this solution with the needful agitation produces the froth, is not certainly known; but the fact is, that (to use the language of the brief):

"* * * its effect (is) to produce a similar action of air bubbles in the attraction of metallic particles, a similar levitation of the metallic particles, a similar persistence of the bubbles, a similar reliable adherence of the air bubbles to the metallic particles, and a similar capacity for final separation of the metallic particles by their overflow, still in attachment to air bubbles, at the top of a vessel containing the pulp."

An observable difference in effect is that the froth of the second patent is composed of bubbles much smaller than the bubbles of the oil process.

We may also note that while the addition of an acid to the mineral-frothing agent is described as part of the process, this was at that time a usual practice, and in any event is not an element in the claims now in issue. The agitation is to be thorough, but in the same connection the means for bringing this about is described in terms that are wide and inclusive. The air or other gas is to be "liberated in, generated in, or effectively introduced into, the mixture," in order that the ore particles may come into contact with the gas and as a result may float to the surface in the form of a froth or scum which can be separated afterward by any well known means. The object of introducing the air or other gas into the mixture is such agitation of the pulp as will produce the desired froth, but the claims are not confined to a particular device or a particular degree of agitation. But, of course, the agitation must be thorough and it must be effective, these being matters for experiment, but always with the ultimate object of bringing the sulphide particles to the surface and holding them there in the grasp of a froth.

We do not find it necessary to discuss the question of validity; our conclusion is, that the patent discloses invention and has not been anticipated. As in the case of the oil process, the patentees seem to have taken "the final step which converted experiment into solution, turned failure into success" (*Minerals Separation Co.* v. *Hyde,* U. S.,); and we find nothing in the prior art that can be held to anticipate. The real question upon this patent also is the question of infringement, and here as well as there the decision turns upon the kind and degree of agitation employed by the defendant. We need not dwell upon the subject, for as the defendant used both processes conjointly it is evident that what has been said about the infringing agitation in the oil process must also apply to the same agitation when considered in reference to the second process. There is this difference, however: As pointed out above, the agitation of the second process is so described as to cover expressly a wider range of means and degrees than is expressly covered by the first process, and therefore needs less aid, if any, from the doctrine of equivalents. For the reasons given in discussing the oil patent, we think the defendant's practices there described infringe also the process now under consideration.

Third Patent

The third patent involved in this suit, No. 1,099,699—also for improvements in ore concentration—was ap-

plied for on June 30, 1911, was issued on June 9, 1914, to Henry Howard Greenway, and has not been judicially passed upon except by the Court below. As stated in the specification, its process is "a modification of the invention described in U. S. Patent to H. L. Sulman, A. H. Higgins and myself, No. 962,678, granted June 28, 1910," which is the second patent here in suit. Greenway's particular object was "to separate certain constituents of the ore such as copper sulphides (for example in the form of copper pyrites or metallic copper natural or reduced) from other constituents, such as gangue, where the ore is suspended in a liquid such as water." After describing the process of No. 962,678, as one "applicable generally to the recovery of metallic sulphides and like floatable metalliferous matter and in case of lead and zinc sulphides to which the process has been largely applied" and stating that in such process "it is necessary for efficient working that the pulp should be lightly acidified, and in most cases in practice the pulp is heated," the patentee disclosed his discovery, namely, that both acids and heat can be dispensed with, saying that, "It is now found that with copper ore such as an ore containing copper pyrites effective separation is obtained in the cold without the use of acid by employing as mineral-frothing agents, aromatic hydroxy compounds such as phenol, cresol, or mixtures containing the same." Upon this disclosure the claims here in issue were granted, illustrative of which Claim 12 is for "a process of concentrating ores, which consists in mixing a powdered ore containing copper with neutral water containing in solution a minute quantity of cresol, agitating the mixture in the cold to form a froth and separating the froth." In the Court below the patent was held invalid and agreeing, as we do, with the conclusion reached by it in reference to the first and second patents, we are the more inclined to follow its decree in reference to the third patent. But an examination of the proofs satisfies us that the process disclosed in this patent was a substantial departure from processes of the prior art. The heating of water is a matter of large moment in large operations, and the use of acid is a matter of constant and considerable expense. By wholly dispensing with both by the use of a minute quantity of hydroxy compounds, the patentee has disclosed an original and novel plan which has broadened and made more simple the agitation process of air flotation. The length of this opinion, rendered necessary in the full discussion of the first patent, is the sufficient warrant for our refraining from a detailed discussion of the proofs and reasons which lead to our conclusion as to the novelty and inventive character of Greenway's discovery, and we therefore limit ourselves to stating that after full consideration we have reached the conclusion that his patent is valid, and, for the reasons stated in discussing the first patent, is infringed by the defendant.

It is ordered that the part of the decree of the District Court holding valid and infringed Claims 1 and 12, and invalid Claim 9, of Letters Patent No. 835,120, and holding valid and infringed Claims 1, 2, 5 and 6 of Letters Patent No. 692,678, be affirmed, and that the part holding invalid Claims 1 to 12 of Letters Patent No. 1,099,699, be reversed; and that a decree in accordance with this opinion be entered.

Montana Section of A. I. M. E.

On the evening of May 21, the Montana section held one of its informal dinners at the Silver Bow Club, Butte, Montana. Forty-seven members and ten guests were present. The purpose of the meeting was to welcome President P. N. Moore of the Institute, and to discuss the general topic, 'How Can the Institute Best Serve the Country in the Present Crisis?' After dinner, F. W. Bacorn, the chairman, made a few remarks on the purpose of the meeting and introduced Col. Dan J. Donohue, who ably discussed the problems of the Army. The Navy was reviewed in an interesting way by Eugene Carroll. Discussion followed by E. H. Wilson and B. H. Dunshee. Mr. Moore then spoke on the relation of the Institute to the Council of National Defense. He paid high tribute to H. C. Hoover and his work in Belgium; and closed with an interesting review of the internal problems of the Institute. Discussion followed by J. L. Bruce, C. W. Goodale, James M. Hyde, J. N. Houser of St. Louis, and Oscar Rohn. On May 22, luncheon was served by the Anaconda members of the A. I. M. E. at the Anaconda Country Club, in honor of President Moore. Covers were laid for 56. After the repast, C. D. Demond called the members to order in the reception-hall and introduced the guest of honor. Mr. Moore contributed anecdotes, advice, and information, all of which were appreciated greatly by all the young men present.

NORMAL requirements of platinum in the United States call for 165,000 oz. per year, part of which is supplied by refining scrap and sweeps. The dental industry formerly used between 25 and 30% of the supply, part of which is not recoverable. Dental manufacturers are now using a number of alloys in place of platinum. The jewelry industry uses between 40 and 50% of the supply, practically all of which would be recoverable if necessity should arise. In 1915 about 44,000 oz., or 4% of the apparent United States stock of platinum, was used in contact-process sulphuric-acid works, producing strong acid for munition makers. The output of contact-process plants has increased nearly 200% since 1915, and it is understood that plants using this process are not yet operated to their full capacity, accordingly there is no pressing need for a large supply of platinum by the sulphuric-acid industry. The government laboratories are apparently well supplied with platinum utensils, and are not in the market for platinum at present, except as investigations on a larger scale may require new equipment. The U. S. mints refine platinum and doubtless have stocks sufficient to meet immediate governmental requirements.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

PLATTEVILLE, WISCONSIN

A Shortage of Labor Restricts Output Somewhat.—New Plants Being Built and Others Planned.—High Prices Stimulate Lessees Throughout the Field.

Intensified activity for about two years or more, in both exploration and development work, has given to the Wisconsin zinc-field a present normal out-putting capacity of not less than 6000 short tons of concentrate weekly. Complete returns from all active mining districts for May, show a complete recovery of little more than 18,000 tons crude concentrate, a rather disappointing output, since the weather-man was prejudiced in favor of the miner throughout the month. Prices for zinc ore for the month were fair on standard and premium-grades, opening the first week in the month at $72.50 base, with the range down to $65; advances were gradual to the end of the month, the second week's quotations going to $75 per ton for top, and $68 for medium and second-grades; third week, $77.50 with the range down to $70; and the remainder of the month at $78 base, with the range narrowed on inferior grades down to $72. Apparently there appeared to be a well-defined policy on the part of high-grade producers and refiners to restrict both output and deliveries. A careful investigation in the second half of the month revealed the real cause for the slump in output. Nearly every village and city and mining-camp in the field was sending more than its lawful quota of fighting-men into the training-camps. Platteville alone sent 168 men, all hand-picked brawny, intelligent, brave men, most of whom came from the mines. Added to the enthusiastic enlistments came another disturbing factor in the working-forces employed in the mines. Many farmers and farm-help flock to the mines each autumn after the harvests, returning to till the soil during the summer season. Cold weather lingering in the lap of spring this year delayed this exodus until well along in the month of May when hundreds left the mines.

Leading operators all over the field were scouring the country for additional labor, which it is found most difficult to replace. One of the more prominent operators declared he could use 200 men and offered a bonus for ready help. To add to this came new embarrassments. There were sharp advances in the price of explosives, approximating 12½%. Likewise in mill-supplies, which tended to offset the higher price of zinc ore. Yet, with all the obstacles placed in the way of operators, May was a period of excellent profit-taking. More high-grade ore proportionately to the output left the field than usual. Refiners all ran at maximum capacity and the associated mines contributed as well as depleted working-forces would allow. Preparations were made for a comprehensive tabulation of expense, which will show the cost of ore production based on the present price of supplies and labor. Several new mines came into production during the month, but in nearly every instance superintendents and mine-managers admitted that the lack of labor was responsible for both restricted output from the mines and the recovery of concentrate from mills. This situation is discouraging prospect-work, and mine development is gradually becoming less pronounced. The New Jersey Zinc Co., for ten years or more one of the most active corporations in the region for the production of zinc ore, is not engaged in mine development anywhere in the field and has no drill-squads at work anywhere on untried ground. In fact, reference to the daily car-reports issued for the mines shows that deliveries of zinc concentrate to the company's refineries at Mineral Point have fallen off from 10 to 15 cars, weekly. Each of the company's mines shows a reduction in the tonnage mined, mainly due, however, to disorganized conditions in several classes of mine employment.

Delegates of the I. W. W. contributed to the discomfort of mine-operators by engaging the attention of miners in the southern districts of the field, where open-air meetings were held and a 5-hour working day was advocated with pay for the usual 9 and 10-hour day. To the credit of the men employed in the zinc mines no chapters were organized and there was no evidence that an impression had been made upon them. Wisconsin zinc miners are a well-paid class of men at this time, as has been pointed out by the publication of the wage-schedule in previous issues of the Mining & Scientific Press. It will be found upon investigation also that every possible care and comfort is being shown the men. Club and reading-rooms, libraries, baths, gymnasiums, and other modern conveniences are being supplied the men near the scene of their labors in buildings especially constructed and provided for their comfort, amusement, and benefit. Several companies set aside large tracts of land and donated thousands of dollars worth of seed-potatoes cutting out working-time to enable their many employees to prepare their allotments of land for planting. It is hard to conceive how any class of men can fail to appreciate the indulgent attitude of the mine operators of Wisconsin. Nearly every company of note in the field has built cottages for men of families, which are occupied free of charge.

That every cloud has its silver lining was illustrated during May in the operations of lead-ore producers, keen-scented individuals on the selling-side of the market when the figures chalked-up on the score-board look nearly right. Real competition developed in this quarter during the month. The Eagle-Picher Lead Co. abandoned the leased smelter at Collinsville, Illinois, and instructed its buyers in the Wisconsin field to buy lead ore. Prior to this move, the New Jersey Zinc Co., which had confined its operations to the buying and production of zinc ore, also placed a buyer in the field, and the price jumped from about $110 per ton, at the beginning of the month to $125 per ton, the second week, and held at this figure the remainder of the month, while the best offerings published for the Joplin field held at about $120. Conservative estimates on the tonage held in the field May 1, was 1200 to 1500 tons. While reports are given out weekly on the total recoveries of zinc ore at mines, no such procedure is seen concerning lead ore. An increased output of zinc ore warrants a larger recovery of lead ore in the Wisconsin field, as most of the lead ore is secured as a by-product in concentration. Sales and shipments jumped from one or two cars weekly to 8 and 10 cars, and a fair tonnage was marketed, but the sold-up condition of the pig-lead market encouraged lead-ore producers into the belief that still better prices were in store for them, and not all the lead ore was sent to the railroad. While not in such pronounced degree as indicated regarding loss of men from mine pay-rolls, nevertheless many miners invaded shallow diggings during the month in the hope that gophering for lead ore would prove more remunerative than the wage at the mines.

The production of iron pyrite during the month was more than ever confined to recoveries made at magnetic ore-sep-

arating plants in the field. The manufacture of sulphuric acid was stimulated at both Mineral Point and DePue, Illinois, where 66° acid is manufactured. Prices for pyrite remained stagnant. In fact it is almost next to impossible to get any of the producers to reveal the prices now being obtained, but that these prices are not satisfactory was admitted by two reliable producers. One large refiner stated that the unrestricted submarine warfare has greatly lessened, if not entirely prohibited, the import of pyrite, and that before long acid manufacturers most likely will make better offers to American producers of iron pyrite and other sulphur ores. Shipments were exceedingly light all month and a careful estimate of ore now held by refiners shows it to be several thousand tons.

Producers of carbonate zinc ore in the northern districts found offerings for this class of ore at sad variance with the quotations published for similar ores in the Joplin region where the price ranged most of the month from $40 to $50 per ton, base of 40% zinc assays. Output was increased appreciably by the introduction of two new mines operated by the New Jersey Zinc Co. and several small local operating concerns that are carrying a small tonnage in the hope of a better demand.

Low-grade blende producers found markets unsuited to a normal output and shipments fell under the usual tonnage reported from this source. The only outlet afforded low-grade producers of large output was the Mineral Point Zinc Company.

Shipments of zinc ore, lead ore, and pyrite for May from mines to refiners and to smelters were as follows:

Districts	Mine-run zinc ore, lb.	Lead, lb.	Pyrite, lb.
Benton	16,480,000	410,000	.....
Mifflin	5,704,000	286,000	.....
Galena	2,614,000	68,000	.....
Linden	2,608,000	.....	142,000
Hazel Green	1,920,000	80,000	.....
Shullsburg	1,012,000	66,000	.....
Platteville	950,000	168,000	.....
Highland	480,000	120,000	.....
Potosi	480,000	111,000	.....
Mineral Point	144,000	.....	1,742,000
Montfort	242,000	50,000	.....
Cuba City	90,000	.....	2,704,000
Total	32,724,000	1,359,000	4,588,000

Shipments of high-grade refinery-ore for the month were made as shown: Benton, 4,854,000 lb.; Cuba City, 3,128,000 lb.; Mineral Point, 4,270,000 lb.; Shullsburg, 348,000 lb.; Linden, 338,000 lb.; total, 12,938,000 pounds.

On account of the falling off in receipts of low-grade ore at Mineral Point a corresponding decrease is shown in the marketing of high-grade separator-ore.

The total net deliveries of zinc ore out of the field for May aggregated 10,792 tons, including the period from May 1 to May 26, inclusive. Of this amount the Grasselli Chemical Co. of Cleveland, Ohio, received 3322 tons; American Zinc Co., of Hillsboro, Illinois, 2548 tons; Mineral Point Zinc Co., DePue, Illinois, 2135 tons; Edgar Zinc Co., 690 tons; Matthiesen & Hegeler Zinc Co., LaSalle, Illinois, 629 tons; Illinois Zinc Co., Peru, Illinois, 487 tons; American Metals Co., Langeloth, Pennsylvania, 461 tons; Lanyon Zinc Co., East St. Louis, Illinois, 280 tons; Highland mines to smelter direct, 240 tons.

Fair weather brought out a diversity of accomplishments in the many mining districts of the field. Highland reported the introduction of two new mills and producers—the new Kennedy-Eberle mine and the Red-Jacket mine; Montfort was excited over a rich strike of zinc ore west of the old workings on the O. P. David tract where Theo. A. Waech, the superintendent, surveyed a new run of ore and the drills showed 8 ft. of solid zinc ore, assays from 121 to 129 ft. running 30% of ore in the rock. Adjoining lands were quickly taken for prospecting purposes; the Linden camp showed wonderful strikes of zinc ore on the Treloar-Kickapoo leases owned by the Saxe-Pollard company, where two new shafts were started one-half mile apart. A new 200-ton power and concentrating-plant will be erected mid-way between the two mines, which will operate both mines and mills. The Utt-Thorne Mining Co. took over the Harris mine and mill at Mineral Point, changing the name to the McIlhon mine and will operate three leases in combination through the central plant. The Dodgeville district reported the completion of a new 150-ton mill on the Berryman farm, for the North Survey Mining Co., operations to begin not later than June 10. The Mifflin district reported two dividend payers, the Big Tom and Peacock mines, both of good reputation in this respect. A considerable tonnage of zinc ore was carried over at this point. The Platteville district failed to show much in the way of production during May, but several new producers got into action—the Mann & Harding mine, New Rose Mining Co., and New Empire Mining Co. The Block-House Mining Co. reaped fair profits on sales of lead ore, carried over $100,000 worth of high-grade refined zinc ore, and paid a dividend of 100%, the third so far this year. The Wisconsin Zinc Co. paid a quarterly dividend of 2%, the fifth, on stock of record May 21, and A. W. Plumb, of Denver, Colorado, succeeded H. C. George as general manager of the company. Drilling outfits discovered extensive deposits of zinc ore on the Weigle tract of 113 acres for the Block-House Mining Co., the title being vested in the operator. Cuba City, the home of two well-established zinc-ore refineries, turned in a fair tonnage of high-grade material not all of which was sent to market, several hundred tons of high-grade being carried over. The Singer-Campbell suffered the loss of one wing of the plant through fire. It is to be replaced without delay. The Utt-Thorne Mining Co. developed ore in quantity on the G. O. P. lease, and building-material and machinery was being assembled for a new plant at the close of the month. Benton district made heavy deliveries of raw ore to refiners and smelters. Especially noteworthy was the performance of both the Frontier and Wisconsin Zinc Co.'s group of mines, the former shipping as high as 27 cars of concentrate in a single week, and from May 1 to May 26, 3457 tons. The aim of the management is to turn in 1000 tons of concentrate weekly and new producers are contributing admirably, especially the Middle mine, a new producer. In the same period the Wisconsin Zinc Co. turned in to its separators at New Diggings 3540 tons of raw ore from which was recovered 2129 tons of 60% blende, sold to the American, Lanyon, and Edgar Zinc companies.

The Longhorn mine, a recent addition to the Wisconsin Zinc Co.'s producers, yielded as high as 10 and 12 cars of mine-run ore weekly. A new mine has been developed for the Wisconsin Zinc Co. on the Copeland estate, in the Shullsburg district, which is now being supplied with a modern mining and milling surface-plant. The Vinegar Hill Zinc Co. introduced a new producer with surface-rig complete. It is known as the Meloy mine. Another producer will be developed for the company on what is known as the New York lease, now being explored with drills. The Felds Mining & Milling Co. made a fair record with one producer, the Thompson mine, shipping, under contract, 23 cars of ore during the month from this one producer to the Grasselli Chemical Co. The New Jersey Zinc Co., on the Fox and Penna-Benton mines, did not report as well as has been the custom. A comparison of mine-run output made in the Benton district with that made by the entire field for the 26 days reported in May reveals the fact that better than one-half of the raw ore mined in the field is coming from this section; the count being 253 out of a possible 452 cars. The Strawbridge Mining Co. of Milwaukee, George E. Orput, formerly of Platteville, manager, was well along with a new 150-ton power, mining, and milling-plant. Ex-

tensive deposits of zinc ore have been proved with drills. The building of a branch railway into the New Diggings camp has inspired new life on all sides, the village experiencing a building boom. In the Shullsburg camp production was revived by the Wisconsin Zinc Co. on a large scale at the Winskill mine. The Oliver Mining Co. continued its large output of refined raw ore, but made light shipments, holding the finished produce for better prices. The Rodhams-McQuitty Mining Co. followed the same programme, carrying over both lead and zinc ore in quantity. The Rowe Mining Co. restored the Milwaukee-Shullsburg mine, installing heavy cross-head pumps.

TORONTO, CANADA

IN ALBERTA 6000 COAL MINERS STRIKE.—EFFECT ON METAL MINES AND MUNITIONS MANUFACTURE.—INCREASED SHIPPING TONNAGE NECESSARY.

The dissatisfaction which has prevailed for some time among the coal miners of Alberta and eastern British Columbia, and who have been demanding an increase of 25% in wages, has resulted in the calling of a strike by the officials of district No. 18, United Mine Workers of America, the headquarters of which is at Calgary. This action affects 6000 miners, the majority of whom, however, had ceased work on their own initiative some weeks before the strike was officially authorized by the union on May 14. This action is seriously affecting the metallurgical industries of British Columbia, as the smelters receive their supplies of coke from the ovens of the Crow's Nest Pass area, which have had to close down by reason of the strike. The smelter of the Granby Consolidated Mining & Smelting Co. at Grand Forks, B. C., has suspended operations, and the closing of the Canadian Consolidated Mining & Smelting Company's plant, at Trail, is anticipated unless the situation improves. As the Granby smelter is the principal producer of copper in western Canada its suspension may considerably curtail the manufacture of munitions in the plants of eastern Canada, which are largely supplied from this source. The Canadian Labor Department has proposed the usual remedy, a Royal Commission of inquiry, but so far the coal-miners are not disposed to listen to any suggestion of compromise, and apparently consider themselves able to dictate terms to the mine operators.

The munition-manufacturing industry has slackened off greatly from other causes, the principal one of which is the completion of large contracts without a renewal of orders. It is officially stated by J. W. Flavelle, chairman of the Imperial Munitions Board, that development in the British Munition plants has reached a point which will render it unnecessary to place further orders for the larger sizes of shells in Canada, but that contracts for the small shells will continue to be placed. Some of the manufacturers, moreover, consider the terms of the later contracts too exacting, and are giving up munition-making. In Toronto operations have been greatly curtailed, and many munition workers discharged. The Fairbanks Morse Co. (Ltd.), one of the largest firms in the trade, has laid off 1100 men and women in this department, and is only running a day-shift in place of full 24 hours.

With the decrease of the demand for shells which bids fair to be permanent, the opportunity for the expansion of the steel-shipbuilding industry has greatly improved. A few weeks since an extensive programme for the building up of this industry was receiving the consideration of the Governemnt, and a number of capitalists. The principal drawback to speedy action was found to be the difficulty of procuring steel. Mark Workman, president of the Dominion Steel Corporation, of Sydney, N. S., recently stated that the entire output of its plant had been contracted for by the Imperial Munitions Board for shell-making up to the middle of 1918, and that in consequence they could do nothing to supply the urgent demand of the railway companies for steel rails. Arrangements are now being made to secure from the Munitions Board a release of the steel necessary for the rails required for renewals on the Government railways. As an increase in shipping tonnage appears to be more urgently required by the Imperial Government than further supplies of munitions, it appears altogether probable that a part of the larger quantities of steel contracted for by the Imperial Munitions Board may be devoted to this purpose. Preparations for securing an ample supply of raw material for the shipbuilding industry are being energetically pushed. The large steel works of the British Forgings (Ltd.) at Toronto, are being hurried to completion and are expected to be in operation about the end of June. The project of the United States Steel Corporation for a Canadian plant on the Detroit river, near Windsor, which had been in contemplation for some years, but was indefinitely postponed owing to the outbreak of the War, has been revived and $9,000,000 appropriated for construction, a site of several hundred acres having been secured. The first unit will be devoted to ship-plates and shapes.

COBALT, ONTARIO

PROBABLE CANCELLATION OF ANNUAL LABOR ON MINING CLAIMS BY THE GOVERNMENT.—OLD HARGRAVES MINE RE-OPENED.—STRIKERS SEEK CONFERENCE.

It is likely that all mining claims in Ontario, recorded prior to April 1917, will be exempt from the compulsory performance of assessment work. Throughout northern Ontario there are at least 3000 claims upon which assessment work will fall due before the end of the current year. Ontario mining claims are obtained by discovery and the performance of assessment-work within 30 days after discovery, 60 days the first year, 60 days the second year, and 90 days the third year. Provided there are 3000 claims on which the amount of work due this year averages 60 days, it follows that 180,000 days of work must be performed in order to keep all in good standing. This would require approximately 600 men working steadily for one year. The energy thus released by the omission of assessment-work would tend to greatly improve the labor supply at the producing mines of this district.

Captain Joergensen, of London, England, president of the Cobalt Aladdin Mining Co., formerly the Chambers-Ferland, is in Canada attending the annual meeting of the company at Cobalt. He has been with his regiment in France since the fall of 1914, and is now on leave for one month.

The Hargraves mine, after being closed for the past four years, was re-opened a few months ago, and made its first carload shipment of high-grade ore this month. The Prince David mine, lying immediately west of the Beaver and Temiskaming mines, has started exploration by a cross-cut from the lower level of the neighboring Lumsden shaft.

The local miners union which is affiliated with the International Mine & Smelter Workers Union, has made demands on the mines at Porcupine, Kirkland Lake, Boston Creek, Gowganda, and Cobalt, and has asked for a conference with the several managers before the end of the month. In the past there has been no tendency on the part of the mine managers to recognize this union nor is there likely to be now. The miners at the Cobalt camp receive the same wages as that asked for by the union, but receive 50c. per shift of this wage in the form of a bonus, based on the price of silver at 70c. Drill-runners at Cobalt receive $4 for an eight-hour shift.

From Porcupine and Cobalt there is now coming a constant stream of silver and gold, amounting to approximately $75,000 per day, Sunday's included; over $27,000,000 per annum. That the industry should be allowed to suffer from a lack of workers is a growing puzzle to not a few mining men of this district, for from present indications, the resources of northern Ontario have not yet reached anything like the limit of expansion.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ALASKA

(Special Correspondence.)—Fred Laubner has taken a contract to drive 500 ft. on a vein for the Gold Cord Mining Co. at Knick. The company has leased the mill of the Independence Mining Co. on Willow creek.——The Wallace Mining & Milling Co. is running a 400-ft. cross-cut.——Fern and Goodell are driving an adit on a 12-ft. vein, the ore running $5 per ton in gold.

The Free Gold Mining & Milling Co.'s plant will start May 21. There is now ready for the mill 500 tons of ore. The Susitna river is still frozen but the ice is expected to break up any day.

Anchorage, May 20.

Juneau

The London *Financial Times* prints the following telegram from F. W. Bradley, president of the Alaska Treadwell Companies:

"A subsidence on the line of the fault-plane hopelessly flooded the workings of the Alaska Treadwell, 700 ft., and the Alaska Mexican mines, but the Ready Bullion mine (belonging to the Alaska United Company) is considered safe. The operation of the Ready Bullion mine, together with commercial operations in connection with the store, the foundry, power and cyanide-plant, and other joint utilities owned by the three companies should yield small earnings for each one of them. There is a hope that eventually a future deep level from the Ready Bullion mine may prospect the Treadwell ore-shoot below the flooded workings. The Consolidation scheme must be held in abeyance and no further expense must be incurred, as the proposed basis is impracticable.

Prince of Wales Island

(Special Correspondence.)—The Mount Andrew mine is located a mile from the beach at Kasaan bay, and is owned by the Mt. Andrew Mining Co. It is being operated at present by W. J. Rodgers. Mining was commenced on April 1 of this year. Ore shipped during May amounted to 750 tons. The shipment during June will reach 900 tons. The ore is delivered to the bunkers at the beach by a 4600-ft. Riblett tramway, and is taken from there by boat to the Granby smelter at Anyox, B. C. The orebodies are large and consist of magnetite and chalcopyrite. Irregular lenses of higher grade chalcopyrite ore are found within the main orebody, and are being mined by glory-hole and other surface methods. The ore shipped to the smelter, after rough sorting in the mine, returns 5% copper and 80c. in gold. Twenty-five men are employed and the mine is worked eight months of the year.

The It mine, owned by the Granby company, is breaking 50 tons of rough-sorted ore daily that averages 5% copper. Fifty men are employed there. The bunk and mess-houses are being enlarged to accommodate a larger number of men.

The Mamie mine, also owned by the Granby company, is closed down. Extensive development has been done on this property during the past three years, and it reached a capacity of 200 tons of shipping-ore per day at one time within that period. It is a fully equipped property and is probably closed temporarily.

Notwithstanding the large number of men that were thrown out of employment by the disaster at the Treadwell mines, there is a labor shortage all along the south-eastern coast of Alaska.

Prince of Wales Island, June 1.

ARIZONA

Gila County

(Special Correspondence.)—A strike of good sulphide ore was made lately in the New Dominion mine at Globe. The vein was found on the 800-ft. level in cross-cutting 60 ft. south of the old Mallory shaft and has widened from 3½ to nearly 7 ft. in driving 20 ft. Shipments from this orebody to the Old Dominion smelter, 1½ miles by road, have averaged close to 8%, according to reports. Recently the old cross-cut to the north has been cleaned out and driving will be continued from the point where operations were suspended about 10 years ago. This was one of the properties which was there, before the panic of 1907, under development by the Globe Consolidated and in which difficulties were met in unwatering the mine. Since then the adjoining workings of the Old Dominion have been considerably deepened so that now the draining of the New Dominion is probably affected by its neighbor to the south. Whatever the cause, the 800-ft. level of the New Dominion is dry, and the shaft may be sunk from 300 to 400 ft. deeper before pumping will be necessary, as the Old Dominion workings are down 1800 feet.

Globe, May 31.

Yavapai County

(Special Correspondence.)—The Arizona Binghamton Copper Co., at Stoddard, is the successor to the Stoddard Mines Company and has developed a large body of chalcopyrite and tetrahedrite, which averages 15% copper, on the 400-ft. level. This orebody has been developed on the upper levels and is being cross-cut for on the 600-ft. level. This company now owns the Stoddard Milling Co., which plant will be increased from 100 tons to 250 tons per day by the first part of June. May copper production will be about 300,000 lb. Ore treated is running over 5% copper.

Stoddard, May 31.

Mohave County

(Special Correspondence.)—The new custom mill at Chloride is expected to be completed by June 15. There is a large amount of ore available to keep the mill steadily occupied and a large output for this promising district is anticipated. Not less than 50 mines are being developed as rapidly as the resources of the owner and lessees will permit, and Chloride is at last about to enter on an era of prosperity long delayed, but none the less assured.

Chloride, June 8.

CALIFORNIA

Reports filed with the State Mining Bureau for the week ended June 2, 1917, show eight new wells started, making a total of 479 since the first of the year; 31 wells were ready for test of water shut-off, 15 deepening or re-drilling and 6 abandoned. The amendments to the law providing for protecting Californian oil fields from damage by infiltrating water have been signed by Governor Stephens and become effective July 28. The amended law will be distributed to all operators at an early date. The changes are of vital importance in meeting the demands caused by the present oil-field activities which are far beyond those of two years ago when the State law was first passed. One of the most important changes provides for local boards of commissioners to be elected by the oil-operators, or land owners, who pay assessments under the law regulating the drilling of wells. The boards of commissioners

replace the special arbitration boards previously provided for, in the law, and also have certain duties in conjunction with the State oil and gas supervisor.

EL DORADO COUNTY

(Special Correspondence.)—The Eldorado Exploration Company of Tacoma is developing a property on the Mother Lode, about 8 miles south of Placerville, and about half way between the Montezuma mine, near Nashville, and the Springfield mine The company has been working on the property during the past year and expects soon to build a mill of 50 tons capacity. There are two veins in the property, several hundred feet apart. Good ore has been discovered at three places and it is the development of these shoots that is now being undertaken. John W. Cover is general manager.

Placerville, June 4.

SIERRA COUNTY

(Special Correspondence.)—Sinking of the 200-ft. shaft at the Mariposa is proceeding 100 ft. deeper, from which point a cross-cut will be driven to the vein. An Ingersoll-Rand compressor, operated by a 150-hp. motor, has been installed, and arrangements have been made for the addition of five stamps to the 5-stamp mill. The property was recently inspected by Nathan Haessly, the president of the company.

Much new work is going on at the Morning Glory, adjoining the Tightner. The shaft is down 130 ft. and will be continued to a depth of 300 ft. Orders will be placed shortly for a pump and other equipment. The mill is running on ore of good grade. The vein averages 4 ft. wide. A. A. Codd, of Reno, Nevada, is manager.

Driving has started from the 100-ft. level of the York-Finney mine, near Downieville, to open the main ore-shoot. As soon as this is done a south drift will be extended to prospect an unexplored part of the property. Rich ore was mined near the surface 20 years ago.

Work has been resumed recently on a number of quartz properties in the Downieville district. At the Alhambra, Rixey and Sporndil are opening the vein with drifts and exposing some good quartz. Preliminary work has begun at the Snow Point, with George Hegarty in charge. Work is proceeding at the Kirkpatrick, near Mountain House, with encouraging results. V. G. Helmet is superintendent.

Good and Hussey are developing a promising quartz property at Bassets Station, a few miles from Beckwith, and have started the erection of a small testing-plant. The ore contains gold, silver, and copper, with the vein several feet wide. The plant will be electrically operated, current being supplied from a small generating-plant at the mine.

Alleghany, June 6.

TRINITY COUNTY

(Special Correspondence.)—Convinced after months of experiments and determined effort that dredging of the rich placers in Morrision gulch is impracticable, the Pacific Gold Dredging Co. has arranged to dismantle No. 1 dredge and move it four miles down Coffee creek to a point near the Trinity river, where the ground is ideal for dredging. This steel dredge cost approximately $400,000. It is constructed to dig in exceptionally difficult ground. The Morrision gulch deposit is stated to carry a high gold content, but the presence of numerous large boulders constantly ripped off the manganese-steel lips of the buckets, despite the use of every precaution. It is reported the company will begin construction of No. 2 dredge at an early date. Meanwhile prospecting of wide areas of promising ground with drills continues.

The Trinity Star Dredging Co. has excavated a pit for the dredge to be operated on the Trinity river, near Lewiston. Unlike most modern dredges, the hull is to be of wood. Lumber is already delivered and machinery is being shipped from Redding. It is stated the ground can be easily dredged.

Considerable work is going forward at the Jubilee and Poeth mines, controlled by the California Extraction Co., of San Francisco. Much good ore has been blocked out and the mill is being improved to effect a satisfactory gold extraction from the sulphide ore, which increases with depth. It is reported that the company plans extensive work at the Headlight mine, which at one time was a good producer.

Carrville, June 4.

TULARE COUNTY

(Special Correspondence.)—The Porterville Magnesite Co., the largest organization mining magnesite in this district, is installing two large electric-motors at their foot-hill plant near Porterville, one of 100, the other of 50 hp. The larger motor will be used to operate the compressor-plant which furnishes air for the seven machine-drills used in mining the ore. These motors replace the gas-engine formerly in use. The smaller motor will operate a new ore-crusher. The new installation of machinery will add materially to the efficiency of the plant, and with the other electric-driven machinery of the plant will consume 330 hp., making this company the largest single user of electric power in the county. The 125-ft. rotary kiln recently installed at the plant is calcining about 200 tons of ore daily.

The California Talc & Soapstone Corporation recently began the mining of talc near Porterville, and is getting out from 4 to 5 tons per day, which is trucked to their grinding-mill at Lindsay. They find a ready market for the talc among the manufacturers of San Francisco and the bay district. It is used principally by manufacturers of soap, fireproof-paint, and rubber.

Porterville, June 8.

COLORADO

TELLER COUNTY

(Special Correspondence.)—Hahnwald, Olsen, and associates, owners of the Queen Bess mine on Tenderfoot hill, working through the 6th level of the Mollie Kathleen shaft, are shipping a 30-ton car of ore per week estimated to average 2 oz. gold to the ton.

Louis Noble has been retained by the Modoc Mines Co. in the capacity of consulting engineer, and the deeper development of the Modoc Battle Mountain mines will be under his direction. Mr. Noble has been engaged in a similar capacity for the Cresson Consolidated Gold Mining & Milling Co., directing new development work. Richard Roloefs, superintendent of the Cresson Con. mine was elected a director of the Modoc Corporation at the last meeting of the company.

The Shoo Fly lease on the Stratton estates Womack hill properties, owned by Aleck Hickman, is producing regularly and making an occasional high-grade shipment. Last week Hickman sacked ore for shipment that assayed 479 oz. to the ton.

Whittenberger and Collins, leasing the Tornado mine of the Elkton Consolidated Gold Mining Co., have loaded out by team their initial shipment, with the expectation of bringing this old producer back to the permanent shipping-list.

Four units of the new Independence mill of the Portland Gold Mining Co. are in operation and treating 1000 tons of low-grade ore daily. The Victor Battle Mountain mill is also handling 500 to 600 tons daily of the lower-grade ores, while all ores of lessees and that mined on company account that runs $10 to $12 per ton, is shipped to the Colorado Springs mill. Extensive plans are under way to mine the large low-grade orebodies for treatment at the Independence mill, which is planned to have an ultimate capacity of 1500 tons daily.

Cripple Creek, June 4.

IDAHO

SHOSHONE COUNTY

The Stanley mine is shipping antimony ore rich in gold, says the Wallace *Miner*. Several years ago the Stanley made shipments of profitable ore, when antimony commanded a lower price than now. The property then passed to the Her-

cules company, and little has since been done toward development until lately. The main working-adit of the Hercules mine, known as the Hummingbird tunnel, passes through the Stanley claim. It is reported that the ore recently shipped came from a drift on the Stanley vein run from the Hummingbird adit.

W. J. Smith, of the Dreadnaught mine, reports 3½ ft. of ore carrying a good grade of lead, zinc, and copper, in a drift run on vein No. 1 from the main cross-cut. Most of the ore is of shipping-grade. There is also 3 ft. of ore of milling-grade exposed. The new development is at a depth of 750 ft. The vein has been opened by cuts and small holes for 1400 ft. along the surface. The mine is on Beaver creek and joins the Toughnut.

MICHIGAN

Houghton County

The Calumet & Hecla company for itself and subsidiary companies, has subscribed for $1,250,000 of the Liberty Loan bonds.

MISSOURI

Jasper County

Over 500 tons of zinc ore was shipped from the Galena district, the last week in May, an increase of 50 tons over the shipment of the previous week. The Black Hills Mining Co. in the same period shipped nearly 100 tons, and the Wayland company 69 tons.

The Wireck 300-ton mill at Tar river has been sold to F. Childress and associates, of Galena, for $250,000, says the Joplin *Globe*. The mill is half a mile south of Tar river near the Bethel mine. Ore was found in the Wireck mine at 240 ft. and a good grade of concentrate was made in the mill. Several mines near the Wireck are said to have large bodies of good ore, among them the Croesus.

MONTANA

Fergus County

(Special Correspondence.)—The Judith Mountain Mining Association has been formed at Maiden to promote the ligitimate mining industry in Fergus county. E. B. Coolidge is president, George Wieglanda vice-president, William Young treasurer, H. J. Mantell secretary, J. L. Stuart, John Alexander, George Wieglanda, and E. B. Coolidge are directors.

The heavy snows of winter have been succeeded by the spring rains that have left roads in a very poor condition. Hauling of heavy machinery, coal, and ore to Maiden is not yet possible so only development work can be done there. A large pump will be installed at the Cumberland as soon as the roads permit.

The foundation is in for a new cyanide-plant of 125 tons daily capacity at Giltedge, in the Judith mountains. There are many thousands of tons of tailing of low value in gold, but sufficient to make their re-working profitable. There is in addition a large amount of 'black ore' that was not amenable to the cyanide-process in the nineties, but which the present lessees believe they can work at a profit. A campaign of development will be started in a search for additional orebodies.

Vincent Gies has commenced work on the Red Metal group of claims in the Cone Butte district and reports ore of good value in copper, silver, and gold.

It is proving difficult to secure an adequate supply of labor at the Barnes-King mine, at Kendall, in the North Moccasins. Only 65 men are employed instead of the customary 100. Production, however, is improving. The old Kendall mine is being worked by lessees in a small way. Cross-cutting from the adit is in progress at the North Kendall and it is hoped that a better grade of ore will be found.

The miners in the Little Rocky Mountains, in Phillips county, struck recently for a raise in pay. About 225 men were affected. The Ruby Gulch, Beaver Creek, and August mining companies mines were closed temporarily. They are located at Landusky and Zortman. Later reports say that the men were granted $4 per day, instead of $3.50, and have returned to work.

Lewistown, June 4.

Silverbow County

A fire was started, it is reported, by the flame of a carbide-lamp igniting a frayed insulation of an electric wire, on the 2400-ft. level of the Speculator mine, on Anaconda hill at Butte, on Saturday. The fire communicated to the mine-timbers, and spread rapidly. Soon the Granite Mountain shaft, an up-cast, with which the Speculator workings are connected, was a roaring chimney of flame. A large number of men were in the mine at the time, but despite the heroic efforts at rescue many lives were lost. A tool-boy, Manus Dugan, aged 20, directed a party of 27 men, who, including himself, retired into a drift and built a bulk-head to keep out the deadly gases. After remaining imprisoned for 36 hours in the drift until nearly exhausted from lack of oxygen, young Dugan ordered the men to break down the bulk-head and make a dash for the shaft. All of this party were rescued alive except J. H. Adams and Manus Dugan, whose whereabouts was unknown. Rescue-crews made every effort to reach and save the miners in various parts of the mine, and numerous lives were thus saved, but many others, it is feared, were suffocated by the carbon di-oxide that penetrated to every open-place in the mine workings.

NEVADA

Churchill County

The Nevada Hills Mining Co., of Fairview, has declared a dividend of five cents per share payable on July 1 to stockholders on record June 20. The total disbursement will amount to about $35,000. The property has been producing for over nine years.

Clark County

The lower adit at the Boss mine has reached the vein, 400 ft. below the upper workings. The ore is described as containing lead, gold, and platinum. A test run is being made in the mill and the recovery is stated to be satisfactory, but a change is to be made in the roasting-furnaces so that the heat of the petroleum-burner may be under better control. Heretofore the heat has varied greatly.

The new strike on the 700-ft. level of the Yellow Pine mine, near Good Springs, is said to be of greater importance than was at first supposed. During the past week, says the Good Springs *Gazette*, the drift has been driven through 20 ft. of solid high-grade ore. The dimensions of the orebody are unknown. The strike was made in untried ground that lies beyond a fault that had displaced the orebody mined above and from there downward.

The Contact mine, near Good Springs, is reported to have cut a 5-ft. vein of zinc ore a few days ago and development is being urged, and arrangements made to send out a shipment as soon as possible.

Eureka County

(Special Correspondence.)—Owing to not being able to get distillate for their hoisting-engine and compressor, the Connelly mine had to shut down, and there is no assurance of getting any for 30 days. The Connelly is being operated by Major Catlin and had from 12 to 15 men on the pay-roll, in charge of Julius Heubner, who has been driving on the 400-ft. level to open-up proved orebodies. As soon as the new electric power-plant at Eureka is in operation, a power-line 4½ miles long will be constructed and sinking to the 1000-ft. level will be continued.

Tony Romana is sorting and shipping matte from the Silver West slag dump, and also has several men jigging the fine. This the present prices of metals allows them to do at a

handsome profit as the ore was only partly smelted in the early days when fluxing was little understood.

The Ruby Hill tunnel, 2000 ft. long, is being cleared out for an examination of the workings driven out from it. This work is done pending a sale of the property.

Eureka, June 3.

HUMBOLDT COUNTY

(Special Correspondence.)—An auto stage-line has been placed in operation between Lovelock, Rochester, Oreana, and Packard, greatly improving passenger service between those places and the railroad. Considerable building activity is evident in both Rochester and Packard, and the outlook is favorable for a busy summer, particularly in the Rochester field. The Rochester Combined company has completed the 4-in. pipe-line from springs in Rochester canyon to the mill-site, and has started building of mine and office structures. Construction of the mill will start soon. Mine conditions are satisfactory. The shaft of the Happy Jack has been re-timbered and is being sunk 200 ft. The vein shows a width of 14 to 16 ft., assaying 36 oz. silver and $3.20 gold. The driving of the Maynaugh adit is making rapid progress. The adit on the Link group is in 105 ft. and cross-cutting is progressing. The Shepherd is developing well, with a large tonnage of ore assured.

The drift from the 900-ft. level of the Rochester mine broke into milling ore last week and is expected to intersect the rich vein exposed on the 800-ft. level at any time. The drift from the 700-ft. level is also nearing this vein. Both drifts on the 800-ft. level are still in ore of shipping grade. A large output is maintained from the 100, 420, and 650-ft. levels, and the mill is running at capacity.

Rochester, June 2.

MINERAL COUNTY

(Special Correspondence.)—With more than a score of properties producing, the Luning district is established among the leading copper districts of the State. Many companies are now strongly financed, and several reduction plants are contemplated. The Pilot Copper Co., of New York, has arranged for the construction of a leaching-plant, which will treat custom ore besides the company product. The Calavada, Empire-Nevada, Nevada Champion, Luning-Idaho, and many others are developing well.

Equipment has been ordered for the new main shaft of the Luning-Idaho, which will be sunk 500 ft. Machinery includes a 50-hp. hoist, compressor, and drills. A small hoist is to be placed at the McDavitt shaft. The Hahn adit is in 535 ft. and has cut two shoots of copper-gold ore. In the Erickson adit ore assaying $36 per ton, principally in copper, has been exposed. In the old workings a large tonnage of shipping-ore is exposed and preparations have been made for shipments. R. H. Todd is superintendent, and John C. Skuse is consulting engineer.

Near Rand the Jumbo Extension company is developing the Copper Mountain mine. A powerful hoist and compressor have been installed on No. 2 shaft and equipment erected on shaft No. 1. In both shafts good ore is showing, and drifts from No. 2 have intersected the orebody developed in the Miller-La Patt lease. Outlying territory is being explored with a core-drill. A spur-track to the mine is being extended from Nolan, the nearest railroad station.

The Queen Regent Merger company expects to have the new hoist and compressor in operation in a few days, when sinking of the 500-ft. shaft another 100 ft. will be commenced. Early shipments are planned from the 500-ft. level. On the 300 and 400-ft. levels the vein is from 10 to 30 ft. wide, with the ore assaying $10 to $20 per ton.

The Nevada Rand company has completed sinking of the shaft to a depth of 450 ft. and is cross-cutting from this point. The vein has been cut and drifts are being extended in search pay-ore. Near the 180-ft. level excellent ore is showing.

Luning, June 5.

NYE COUNTY

(Special Correspondence.)—An extremely heavy flow of water was encountered in the shaft-sinking at the White Caps a few days ago. It was necessary to devote practically the entire week to the work of fighting the water.

The regular sinking-pump, a No. 5 Cameron air-pump, for a time was unable to keep the water down. An additional sinker, a No. 7 Cameron, was brought from Tonopah and is working in conjunction in the shaft-draining operations. Since the second pump has been working, the flow has diminished and the miners are at work in the shaft bottom, and from now on little trouble with the water in the shaft is expected. The shaft is now 72 ft. below the fourth level. In the east drift, the water is decreasing, though no further development has been done since the water was struck two weeks ago. Several drill-holes have been put in the face of the drift to expedite the draining of the water. To handle the water from the levels, the large station-pump on the fourth level, a 6 by 8-in. triplex, now has an 18-in. pulley replacing one of 12 in., thus speeding up the pump. The 4 by 6-in. triplex on the third level also is kept working. The total volume of water from the four pumps is 375,000 gal. per day. The mill is nearly finished. The brick-work of the first hearth and the centre-column of the Wedge roaster is nearing completion. The elevator-hoist for the roasted ore has been raised into position, ready for operation. In the tank-building, the canvas and cocoa-matting bottoms for the leaching-tanks have been laid, the piping to the fresh-water storage-tanks above the mill is complete, and within the next few days all the mill tanks will be filled with water. The machinery in the roll-house is being installed; the trommel is in place, also the whip-tap shaking-screen. The Pipe Springs cut-off wagon-road has been completed to the bottom of the hill east of the first summit from the mine. The road should be ready for use within two weeks. The plans for the White Caps assay-office have been drawn and work will be commenced on the building as soon as the rush of mill work has slackened.

At the Manhattan Consolidated Mines Development Co.'s property the lateral work from the shaft on the 300-ft. level has reached a point 110 ft. east. The drift has been running parallel with the mud-dike, the strike of which is 70° north of east. The direction of the drift was changed, the last 10 ft. being run 25° south of east, which will bring the line directly across the mud-dike, and should reach the vein at a point nearest to the shaft. The last 10 ft. of the drift has shown more water than previously. The water in the mine so far has been handled by bailing, but at any time the pumps may be required.

At the Morning Glory the shaft has reached a depth of 100 ft. where there is a change in the formation, the limestone being silicified, and showing considerable iron, although some sulphide also shows. The management announces that a 50-hp. three-drill compressor has been purchased from Silver Peak. The new 45-hp. electric hoist is being installed. It is planned to erect a large engine-house so that both the hoist and compressor can be placed under one roof.

The east cross-cut in the Extension mine from about the 100-ft. level has been following a break in the lime, and has been in medium-grade ore for 10 ft. Some sulphides show in the floor of the cross-cut near the face. This apparently is the same formation as that seen in a large cropping on the surface. Upon reaching greater depth a large orebody is expected, judging from the conditions as developed.

The east drift from the 600-ft. level in the Amalgamated has been extended 42 ft. during the week, now being out from the shaft 252 ft. Ore from development work in the vein, No. 2 raise and from stope No. 4 west, has supplied the mill during the week. The fissure and No. 4 stope, west, carry the usual grade of ore. No. 2 west, on the hanging-wall vein has shown improvement in the last 10 ft. Indications point to the foot-wall vein making ore in this territory.

The shaft in the Red Top is down 90 ft. and is in heavy blue lime, having passed through the broken limestone which carried some gold. The footage made in sinking has been all by hand work, and most of the time in very hard ground.

The three sets of lessees operating on the southern part of Union No. 9 claim of the Dexter Company are extracting ore. In each case cross-veins have been discovered and high-grade ore is being hoisted. The Juhl-Fogle lease has reached a depth of 100 ft. and they are stoping very rich ore.

The drift west from the Doris working-shaft is in a porphyry dike, and the face shows considerable oxidized ore, carrying gold. The porphyry is more silicified as the drift advances, and it is expected soon to reach a vein.

The raise from the 300 to the 200-ft. level north from the working-shaft in the Big Pine, under the north glory-hole, holed-through yesterday. The Big Pine has been one of the most important and regular producers in the district. The north glory-hole produced ore which averaged in the mill $3 in gold. The Big Pine mill has neither rolls nor stamps. From the Gates rock-crusher, the ore goes to the tube-mill, one of the largest in use in Nevada, and from there over the plates; the oversize from the tube-mill, through a closed-circuit returning for re-grinding. In one part of the mill iron balls are used and in the balance of the mill Maris chalcedoney pebbles, a local product, are employed for the fine-grinding.

The winze to the west of the shaft in the Train Chase lease on the Mustang, has demonstrated that the last 30 ft. carries rich sulphide gold ore. In the east winze the character of the high-grade ore is changing into sulphides. As fast as the ore is mined it is sacked and hoisted to the surface, for shipment to the smelter. Two shifts are engaged on the lease. It is stated that the new management intend to commence mining operations in the old company working-shaft.

At a special meeting of stockholders of the Mustang Extension Mining Co., the articles of incorporation were amended to increase the capital stock of the company from 1,000,000 to 1,500,000 shares. It is planned to place the additional stock in the company treasury to obtain funds for carrying forward an extensive campaign of development.

Manhattan, June 7.

OREGON

Jackson County

(Special Correspondence.)—Several Gold Hill miners returning from the Buzzard mine in the Elk Creek district, 40 miles north-east of Gold Hill, report that the lessee, Paul Wright, is making good progress in the development work at the mine. The new work consists of an 850-ft. drift on a stringer of sulphide ore on the opposite side of the hill from the old works. This drift will cut the main vein at a depth of 300 ft. The work is being crowded with two shifts. The old works consists of 3009 ft. of drift. The greatest depth is 170 ft. on the vein. The orebody strikes north-west.

The property is owned locally by the Pearl Mining Co., of Central Point. The machinery equipment consists of a jaw-crusher, a small Huntington mill, and a Frue-vanner, operated by steam-power.

Some of the highest grade sphalerite known in the State has been produced from this mine. The last shipment made late in 1916, consisted of four tons, which returned $2100.

Elk creek is a new district in the north-eastern part of the county; Gold Hill being the nearest and most practicable shipping-point. The geology of the district consists of a series of flat-lying Cascade andesite flows. Vertical fissuring has taken place locally, producing fractured zones, which furnished opportunity for the mineralizing waters to deposit ore in the crushed or brecciated rock. It is a heavily forested area and is within the Crater National Forest. The elevation of the district varies from 2000 to over 5000 feet.

Gold Hill, June 6.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

David J. Pullinger is at New York.

James M. Hyde is at Ouray, Colorado.

Walter Douglas is at the Fairmont hotel.

Charles Butters has gone to Washington.

William W. Mein is expected here shortly.

Alf Welhaven sailed from Korea on June 6.

Bernard MacDonald is leaving for Antofagasta, Chile.

F. A. Beauchamp will be in Arizona for several weeks.

W. L. Watts has returned to Los Angeles from Vancouver, B. C.

C. E. Wuensch, on his return from Salvador, has gone to Arizona.

Herbert C. Charles, recently at Lovelock, Nevada, is in San Francisco.

John H. Eggers is making a trip to Arizona to make an examination.

J. S. Diller was in San Francisco and has gone to Porterville, California.

J. E. Spurr passed through San Francisco on his way to British Columbia.

Curtis H. Lindley has gone to Washington to co-operate with H. C. Hoover.

R. S. Black has been elected president of the Australasian Institute of Mining Engineers.

L. D. Mills, of the Merrill Metallurgical Co., has been at the Portland mill, Cripple Creek.

G. W. Laurie is superintending the building of a copper-concentrating plant at Baltimore, Maryland.

H. G. Young has been granted a commission in the Canadian Engineers, and is now at St. Johns, Quebec.

W. E. Fenwick has resigned the superintendency of the Francisco mine at Acostas, Pinar del Rio, Cuba.

W. R. Degenhart sails for Burma on the 16th inst., returning to Bawdwin mines of the Burma Corporation.

C. C. Everenham, of the Dome Mines, Porcupine, has been visiting the Portland mine at Cripple Creek, Colorado.

E. Gybbon Spilsbury sailed from New York on June 5 for Central America and expects to be absent until the middle of July.

H. deS. Kennedy is in charge of the construction of a 200-ton mill for the Boston American Mining Co., at Monte Cristo, Washington.

Jay Loneegan has retired from the professorship of mining engineering in the University of Peking and has returned to the United States.

John A. Fulton is acting manager for the Melones Mining Co., California, in the absence of W. G. Devereux, who is engaged in military duty.

Robert S. Lewis has returned to Salt Lake City, after examining a mine in Arizona. He will spend the summer at Huntington Lake, California.

Julius M. Cohen, manager for the Croesus Gold Mines, Limited, at Matheson, Ontario, has been appointed a first lieutenant in the United States Reserve Corps.

O. H. Reinholt has returned to San Diego from Inyo county, and is now on his way to examine properties in the Middle West, and as far east as Birmingham, Alabama.

Samuel W. Cohen, general manager for the Crown Reserve Mining Co., Ltd., and the Porcupine-Crown Mines, Limited, has returned to Montreal after a two months trip to California.

W. J. Pike, for five years superintendent of the Jim Butler mine at Tonopah, has resigned and is now superintendent for the Consolidated Spanish Belt Silver Mining Co., also at Tonopah.

THE METAL MARKET

METAL PRICES

San Francisco, June 12

Antimony, cents per pound	21.50—22.00
Electrolytic copper, cents per pound	31.50
Pig lead, cents per pound	12.25—12.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$90
Spelter, cents per pound	11.50
Tin, cents per pound	60
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, June 12

Antimony, 50% metal, per unit	$1.55
Chrome, 40% and over, f.o.b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tin, cents per pound	60
Tungsten, 60% WO_3, per unit	20.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 45% (under 35% metal not desired), cents, unit	36—38

Manganese prices and specifications, as per the quotations of the Carnegie Steel Co. schedule of prices per ton of 2240 lb. for domestic manganese ore delivered, freight prepaid, at Pittsburg, Pa., or Chicago, Ill. For ore containing

	Per unit
Above 49% metallic manganese	$1.00
46 to 49% metallic manganese	0.98
43 to 46% metallic manganese	0.95
40 to 43% metallic manganese	0.90

Prices are based on ore containing not more than 8% silica nor more than 0.2% phosphorus, and are subject to deductions as follows: (1) for each 1% in excess of 8% silica, a deduction of 15c. per ton, fractions in proportion; (2) for each 0.02% in excess of 0.2% phosphorus, a deduction of 2c. per unit of manganese per ton, fractions in proportion; (3) ore containing less than 40% manganese, or more than 12% silica, or 0.225% phosphorus, subject to acceptance or refusal at buyer's option; settlements based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken to be deducted from the weight. Prices are subject to change without notice unless specially agreed upon.

EASTERN METAL MARKET

(By wire from New York)

June 12.—Copper is firm, with futures stronger. The price has been 32.75c. throughout the week. Lead is strong and higher at 11.75 to 12c. Zinc is dull but firm at 9.75c. all the week. Platinum remains unchanged at $105 for soft and $111 for hard.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
June	6	May 1	74.06
"	7	" 8	74.92
"	8	" 15	74.69
"	9	" 22	74.78
"	10 Sunday	" 29	74.62
"	11	June 5	74.80
"	12	" 12	75.83

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	72.51	Oct.	49.40	67.86	....
May	49.87	74.27	74.61	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

The weekly letter of Samuel Montagu & Co., of London, on May 10, says:

During the week the market has been exceedingly quiet, and there being but little competition for the small amounts offering, the price has shown a drooping tendency. There was sufficient inquiry on Friday, May 4, to maintain the price at 38⅛d., but on Saturday it fell ⅛d. A further fall of 1/16d. occurred on the 7th, bringing the quotation to 37 15/16d., at which figure it remained until the 9th, only to drop a further 1/16d. today, when it was quoted at 37⅞d.

The sales from New York continue very small and there is but little speculation either in buying or selling.

The following is taken from the 'Times' of May 4:

"According to the Schleswigsche 'Grenzpost,' nickel and silver coins will shortly be cancelled in Germany and replaced by others of metal or by paper. This is due to the increased hoarding that is going on."

As far as silver is concerned this threat is not very terrifying, inasmuch as those who are now hoarding silver marks are doing so because they believe that after the War these coins will very likely be more valuable as bullion than as currency.

The stock in Bombay consists of 1700 bars as compared with 1500 bars last week. The stock in Shanghai on April 5 consisted of about 27,500,000 oz. in sycee, and $17,600,000, as compared with about 26,800,000 oz. in sycee, and $17,400,000 on April 28.

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	43.25	51.49	55.63	Oct.	33.00	41.10	....
May	39.28	49.10	63.21	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Tin has been the principal item of Bolivian export for many years, the bulk of the production having been shipped to Great Britain, even after the War broke out. During 1915 about 35,360 metric tons of 2204.6 lb. of tin ore was sold to Great Britain, while the United States, which held second place on the list of buyers, received only about 1100 tons. During 1916, however, the United States purchased this mineral in increasing quantities, and it is estimated that about one-half of Bolivia's production is now being sent to the United States. The total exportation of this ore during 1915 was about 36,492 tons. In addition to the exports to Great Britain and the United States, Germany took 27 tons, Argentina, 2 tons, and Uruguay and Chile, 1¼ tons.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
June	6	May 1	30.43
"	7	" 8	31.37
"	8	" 15	32.00
"	9	" 22	32.25
"	10 Sunday	" 29	32.50
"	11	June 5	32.62
"	12	" 12	32.75

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.37	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	33.16	Oct.	17.90	28.50	....
May	18.71	29.02	31.69	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
June	6	May 1	9.62
"	7	" 8	9.93
"	8	" 15	10.49
"	9	" 22	10.50
"	10 Sunday	" 29	10.93
"	11	June 5	11.46
"	12	" 12	11.83

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.82	6.80	....
Apr.	4.21	7.70	9.38	Oct.	4.62	7.02	....
May	4.24	7.38	10.29	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound

Date		Average week ending	
June	6	May 1	9.23
"	7	" 8	9.61
"	8	" 15	9.37
"	9	" 22	9.37
"	10 Sunday	" 29	9.50
"	11	June 5	9.66
"	12	" 12	9.75

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	10.20	Oct.	14.05	9.92	....
May	17.03	16.01	9.41	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date			
May	15	106.00	May 29 — 95.00
"	22	95.00	June 5 — 90.00
			" 12 — 90.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	114.50	Oct.	92.90	78.20	....
May	75.00	90.00	104.00	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

ANTIMONY

The metal is lower on less demand and large arrivals. Chinese and Japanese grades can now be obtained for early delivery at 21 to 22c., duty paid, New York.

PLATINUM

Platinum is quoted at $105 for soft unalloyed metal and $111 for the hard natural platinum-iridium alloy.

ORES

Tungsten: Some dealers report that considerable business has been done in the past 10 days both for domestic and foreign account, while others say that little demand has appeared, indicating that it depends on the dealer as to just what view of the market is obtained. Unquestionably sales have been made for both accounts, and in some quarters the statement is made that not enough ore, especially American, is available. The quotation is firm at $20 per unit for 60% concentrate. Ferro-tungsten is quoted at $2.25 to $2.50 per lb. of contained tungstic acid, some stating that it might be shaded down to $2 to $2.15.

Molybdenum: The market is firm at $2.20 per lb. for molybdenum in 90% ore. Some business has been done at this figure.

Antimony: Contracts for ore from South America are reported closed at $2.35 to $2.40 per unit.

Eastern Metal Market

New York, June 6.

The metals are all quiet and dull though mostly strong. The holidays, one on Decoration Day and another on registration day yesterday, which was almost entirely a holiday, have tended to lessen business.

Copper is quiet, but has a firm undertone with an advancing tendency.

Zinc is dull but steady and firm.

Lead continues to maintain and, if anything, to increase its strength.

Tin is lower and less active.

Antimony is again lower but very quiet.

Transactions in the pig-iron market the past week confirm what has been well-considered opinion in the steel trade for some weeks, that future war advances were likely to come as abruptly as any that have come in the past two years and might go to lengths even now thought impossible. The arrival of $50 pig iron was seen at Pittsburg last week when Bessemer iron, to the extent of 75,000 tons, was sold at from $46 to $50 per ton, 20,000 tons having gone at the latter price. Semi-finished and finished steel have been affected by these sales and have advanced too. All steel-scrap markets have also been stirred and heavy sales at advancing prices are recorded. The labor-supply is causing concern. At Chicago the exodus of men to farms is a serious factor and steel-mills and machine-shops generally will need Government help in order to maintain forces in the face of the new conscription movement.

Pig-iron production in May was 3,417,340 tons, or 110,238 tons per day against 111,165 tons per day in April. But the number of furnaces now on the active list was 340 on June 1, the largest number in many years.

COPPER

Copper prices for nearby delivery, such as June and July, are largely nominal at 32.50c., New York, for both Lake and electrolytic, with metal for these deliveries obtainable generally only through second hands. Quotations for spot delivery are quite a little higher, but vary according to seller and conditions from 33 to 34c., New York. The situation as to third quarter, or really only August and September, is mixed, quotations varying from 30 to 32c., New York, with fourth quarter pegged at 29 to 30c. In general there has been nothing going on in the past week, due to holidays and general lack of demand. The market is quiet but very firm, with the tendency upward. Business of any volume for any position is not reported, though a little has been done here and there as always. No news is forthcoming regarding the probable needs of the Government and its allies nor as to the price to be paid. Some think there will be a scarcity when full demands are realized in spite of the fact that production is very large. The question as to the price to be paid by the belligerents continues to be discussed with the preponderance of opinion in favor of not less than 24 to 26c. per lb. But there are some who favor openly a much lower price and openly publish their views and arguments. As bearing on this point the following comment by a prominent critic is of interest:

"Something was said in Congress last week about 'the men who are holding the price of copper up to 30c.' The price is being maintained by a thoroughly legitimate excess of demand and not by manipulation or speculation. The Congressmen who make the attack on the producers probably would be surprised to know that it would be impossible for him to buy 1,000,000 lb. of copper from any of the large producers in the United States if he were to appear in person with cash in hand. The producers make it a rule not to sell copper to speculators, insisting in all cases that the purchaser must be a *bona fide* consumer or the representative of one.

"There is no copper trust, no regulation of prices, and the producing companies are exerting every power they possess to increase the volume of their output. There is no more reason why copper should be sold at cost, at the average price of the past ten years, or at any other price than that established by demand and supply, than there is that metals in general, including gold and silver, should be so sold. The Government's recent purchases of silver at much higher prices than the average of the past ten years provoked no discussion in Congress. There is now every indication that consumptive requirements, including those of the great War, will continue to exceed production. Unless the volume of output can be increased further, or consumption in industrial lines decreased, the metal is likely to sell considerably higher."

TIN

The tin market is always affected by holidays, perhaps more than other markets. With Decoration Day last week and practically a holiday on registration day yesterday, together with an intervening Saturday, the market has been decidedly quiet—in strong contrast to the past two or three weeks. It has come almost to a halt, due largely to conditions at Washington. On a small volume of business prices have declined considerably the past week or from 65c. on May 28 to 60.25c. yesterday, a decline of nearly 5c. per lb. in a week. This has been due to several causes. Lack of demand is one, and larger arrivals another, but the feeling is growing stronger that shipping permits from England will be easier if anything. It is expected that the monthly statistics, not yet available, will show a considerable increase in the visible supply. It is also interesting to note that the Straits shipments of tin for May totaled 6866 tons against 3965 tons in May, 1916. Of decided influence, as affecting the decline here, has been the fall in prices in the London market. Spot Straits was quoted there yesterday at £239 15s., which is about £14 per ton less than it was a week ago. Arrivals to June 4, inclusive, are reported as 300 tons, with the quantity afloat, 2052 tons. The average price for tin for May was 63.21c., New York.

LEAD

Lead has been the only interesting market of the week. It has been and is still very strong and advancing, but the tendency has been ragged. Large producers continue more or less out of the market and hence supplies are not abundant. Re-sale lots have appeared, but the interesting feature is that both the St. Louis and New York prices are on a level at 11.50c., which is rather unusual. Some business has been done at less than this, at 11.25c., New York, but it has been only in odd lots. The Government's needs are still a mystery, but it is known that they will be large, and a strong market is confidently expected for some time to come. The quotation of the American Smelting & Refining Co. is unchanged at 10c., New York, though it was expected that this would be advanced on Monday. The spread between this price and that of the open market is 1½c., or the largest ever known. An advance to 10.50c., or even 11c., is not improbable in the near future.

ZINC

The market continues firm and dull. Demand is not active, but underlying conditions are such as to make it strong. One dealer terms it a 'curious market' in that it is not only dull and inactive but futures are really higher than early deliveries. The former has been sold as high as 9.50c., St. Louis, or 9.75c., New York, while metal for early delivery can be obtained for from ⅛ to ¼c. lower. The general expectation is that in the not distant future higher prices will probably prevail, and sellers are reluctant to part with their metal except at satisfactory prices. Demand is not strong for any position.

INDUSTRIAL PROGRESS

Motor-Trucks Are Big Aid in Army Service

"Mobilization of the U. S. Army on the Mexican border and the return of the National Guardsmen to their home States, emphasized the important part the motor-truck is playing today in the Army," declared H. M. Lee, president of the Duplex Truck Co. of Lansing, Michigan.

"The motor-truck was found to be almost indispensable on the border. It hauled capacity loads quickly from one camp to another. Equipment was transferred from one place to another in one-fifth the time that would have been required with mule teams.

"From reports I have received, a Duplex truck went places where mule or horse-teams could not have ventured—and it carried capacity loads throughout the nine months it was on the border. It hauled hundreds of tons of provisions, baggage, and equipment for the soldiers and often was on the job day and night.

"Again the importance of the motor-truck was emphasized when the two Lansing batteries of field artillery returned from the border. Thirty trucks transferred the tons of baggage and equipment from the railroad to the Artillery armory—and the trucks reached the armory with the National Guardsmen. It was not necessary to wait for baggage or equipment. Everything arrived on schedule time with the soldiers.

"Few realize the great amount of baggage and equipment required by our soldiers, but it was shown that there was a truck load for every eight or nine returning artillerymen. It is important when such equipment is to be transferred from point to point that it should go with the soldiers—that there should be no delay. The motor-truck seems to have solved this problem."

The accompanying photograph shows a Duplex truck after it had pulled two trailers and 16 artillery caissons—a total load of over 20 tons—several miles over the streets of Lansing.

DUPLEX AUTO-TRUCK AND TRAIN OF WAGONS

United Filters Corporation

The United Filters Corporation, through the purchase of all the patents, assets, and good-will of the Kelly Filter Press Co., the Sweetland Filter Press Co., and the American Filter Co., becomes the sole owner of the most valuable patents covering filter-apparatus of various kinds and descriptions in all parts of the world. The United Filters Corporation is a corporation of the State of Delaware; capital $2,000,000, two hundred thousand shares of stock of the par value of $10. Stock all one class. Issued stock, $1,025,000, 102,500 shares, fully paid; stock in treasury, $975,000, 97,500 shares. No bonded or mortgage indebtedness of any character.

The filter requirements of the world have been met by small companies working independently under heavy selling and operating expense because of the duplication of expense and services in canvassing the field. Great economies, therefore, will be secured by this new company, inasmuch as the marketing of the various types of filters will be done by one set of engineers under the supervision of one management. Large savings and economies will be effected in manufacture and in engineering departments on account of the much larger volume of business controlled through one organization and the proportionate decrease in overhead expenses of all kinds.

The officers and directors of the corporation are the following: O. J. Salisbury, president and director, Salt Lake City, Utah; E. J. Sweetland, vice-president and director, New York City; L. B. McCormick, treasurer and director, Salt Lake City,

Utah; J. B. Walker, Jr., director, New York city; Halstead Lindsley, director, New York city.

The main office is in the Felt building, Salt Lake City, and the Eastern office is at 120 Broadway, New York.

The Electric Whistle

An electrically operated whistle has been developed and is now being made in three sizes.

The cut illustrates the single-head type, which is equipped with a 1½-hp. motor. The motor is shown, although a housing is supplied to protect it from the weather.

The cost of maintenance and up-keep for the electric siren is much less than that of a steam-whistle. Another advantage over the steam or compressed-air whistle is that it can be blown automatically from one or any number of points about the plant, and that it does not require an experienced

THE ELECTRIC SIREN

engineer to maintain and operate it. While it is not in operation the cost is nil, requiring but a little oil once a month. The approximate distance of sound-penetration for this size is ½ to 1 mile radius.

There is a larger size manufactured, known as the double-head, which has another siren-head attached to the commutator-end of the motor-shaft. This size has a double volume of sound efficiency, and is equipped with a 2-hp. motor for three-phase or direct-current, and a 3-hp. motor for single phase. It meets the demand for a device louder than the single-head type.

A small size, known as the type A, is also manufactured for use in mines, quarries, and industrial plants. Any number may be wired in multiple and operated from one or more selected locations. The sound is distinct from that of the average steam-whistle or gong, thus making it especially suitable for fire-alarm or disaster signalling. The type-A siren is equipped with a small motor, approximately 1/12 hp., and may be wound for any standard electric-current. The shipping weights vary from 50 to 150 pounds.

Electric-Drive for Battleships

Contracts totaling approximately $2,000,000 have been placed recently with the Westinghouse Electric & Mfg. Co. of East Pittsburg, Pennsylvania, by the New York Shipbuilding Co., for furnishing the necessary electrical equipments for the propulsion of the new super-dreadnaughts *Colorado* and *Washington*.

The equipments to be furnished are practically duplicates of that contracted for by the Navy for the U. S. S. *Tennessee* now building at the New York Navy Yard. The four propellers, as in the case of the *Tennessee*, instead of being mechanically connected to driving-engines, or turbines, are to be driven by individual motors. The current for the motors will be furnished by two turbine-generators.

In addition to the main generating equipments and propelling motors, the contracts include auxiliaries for the main turbine-generators and smaller auxiliary turbine-generators for supplying light and power throughout the ships. Westinghouse electric motors also will be utilized for doing nearly all the work on board from raising the anchor to steering.

Commercial Paragraphs

M. P. O'Brien has organized the Milwaukee Electric Crane & Manufacturing Co. at Milwaukee, for the purpose of building electric traveling-cranes.

The Powell automatic injector, manufactured by the Wm. Powell Co. of Cincinnati, Ohio, is made in six different sizes. The injector is made of steam-bronze composition and is suited to every make of steam-boiler. Those who desire further information concerning this excellent device for feeding water to boilers can secure it by making application to the company.

The Denver Hydro Co. has issued a pamphlet, Bulletin No. 7, descriptive of a small portable air-metre for measuring air for mine-service and checking the increased air-consumption of air-tools and rock-drills, due to wearage. This device indicates any air loss, determines the most efficient tool, and gives a perfect check on wearage. It is guaranteed to be accurate.

The De Laval Steam Turbine Co., of Trenton, New Jersey, has issued an attractive pamphlet entitled 'Progress in Water-Works Pumps.' It treats the subject thoroughly, describing and illustrating the various parts of the steam-turbine pumps made by that firm. It also briefly describes a number of important municipal installations: at Montreal, Cleveland, Philadelphia, San Antonio, Indianapolis, and other cities, giving interesting and valuable data regarding capacity, efficiency, and cost.

Chalmers & Williams, of Chicago Heights, advise us that among the large concerns, the following have recently installed Symons disc-crushers: The Hollinger Gold Mines, of Ontario; the New Cornelia Copper Co., of Arizona, thirteen crushers; the Federal Lead Co., of Flat River, Missouri, four; The Burro Mountain Copper Co., of New Mexico, two; the Chile Exploration Co., of Chile, six; the Calumet & Arizona Mining Co., of Arizona, two; and the Foldal Copper & Sulphur Co., of Norway. In some instances these machines have replaced other devices.

The American Steel Export Co., Woolworth building, New York, where it occupies all of the 29th and 30th floors, has issued a booklet descriptive of what that company will do for those requiring expert engineering advice and service, and how they do it. The company wants to know what your requirements are, and knowing them, is prepared to submit plans and specifications for procedure. They will furnish estimates of cost, of a part, or of all your work, including engineering designs, materials, and full equipment. They are prepared to undertake machine equipment of any kind. They have representatives in every part of the world, and through its export engineering and contracting department, offers a trained and specialized organization under the expert guidance of a chief engineer with 15 years experience in directing such activities and able to truly represent American mechanical ingenuity and industry. The booklet referred to may be had on application.

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Address .....

Tonnage .....Character of ore .....

.....

What is present method of crushing.....

Remarks .....

.....

My name and position.....

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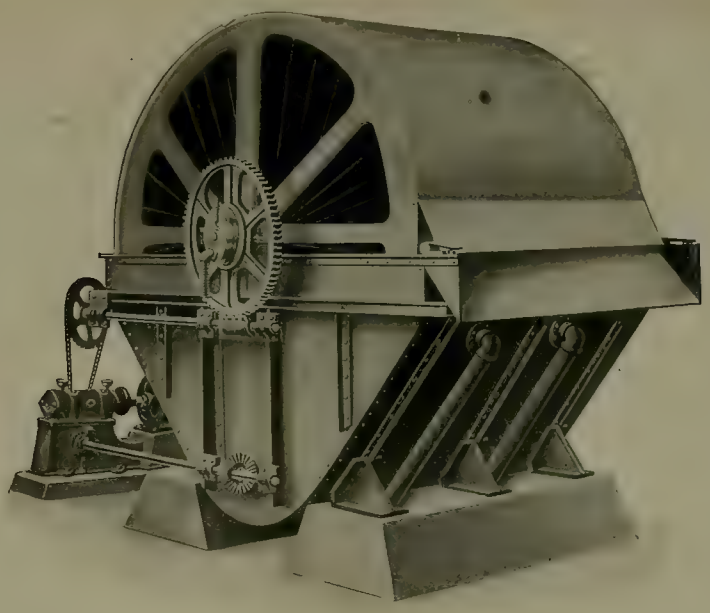

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EDITORIAL STAFF:
T. A. RICKARD - - Editor
COURTENAY DE KALB,
Associate Editor
W. H. STORMS - News Editor

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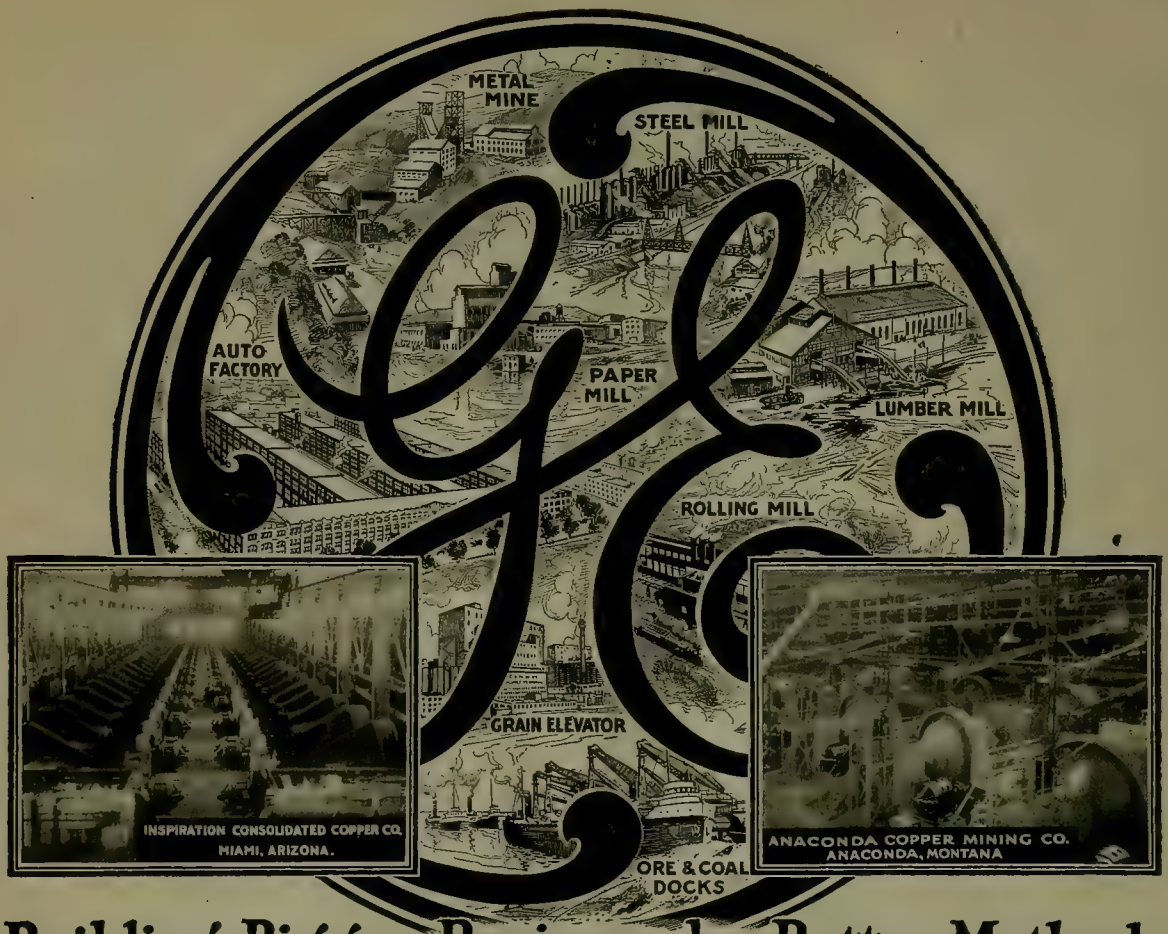

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EDITORIAL

T. A. RICKARD, Editor

CAN any of our readers give us information concerning the use of soluble frothing-agents prior to April 1909? The matter is one of great interest, in view of the Minerals Separation claim to a monopoly in the use of such agents in flotation.

ELECTROLYTIC ZINC will soon be produced from a plant having a daily capacity of 10 tons that is now being erected by the Bunker Hill & Sullivan company at Kellogg, Idaho. This is but the first unit of a large reduction works that later will treat zinc concentrate obtained as a by-product from many of the lead mines of Idaho.

PIG-IRON is selling at $50 per ton, and Connellsville coke has merrily followed its crescendo with large sales at $9.50. Predictions of $75 iron are freely made in view of the singular phenomenon that 'futures' in the iron-market are quoted at a higher price than the 'prompt' metal. These exaggerated quotations are due to active bidding among buyers for a place as preferred customers to meet their needs under contract for later delivery of manufactured articles.

STOCKS of metal held by the American Smelting & Refining Company are said to be carried on that company's books at 12 cents per pound for copper, 3.88 cents for lead, and 5.50 cents for zinc. Comment on these figures has been made, the company being praised for its conservatism. The figures are interesting, because, of course, they represent an estimate of cost, it being customary among manufacturers to inventory their product when in stock at cost. Moreover, the estimate of cost, in each case, seems to us in accord with facts.

COPPER is the subject of an interview with Mr. Adolph Lewisohn in the *Magazine of Wall Street*. Mr. Lewisohn's opinions on the subject command respect. He says that a large demand for copper will persist for the duration of the War; spot metal is scarce and there is a constant call for late delivery, owing, in part, to the requirements of the shipping industry. As to the market after the War, he expects Germany to become a large purchaser, but he suggests that the Germans may have found a substitute for copper in the manufacture of munitions and they use a good deal of this copper over and over again. He is of the opinion that copper shares are "cheap" now, but this seems an optimistic touch, having regard to the probable regulation of price by the Government, acting not only for the United States, but for our Allies also. Mr. Lewisohn hazards the guess of an average price of 20 cents for the next decade and suggests extremes of 15 and 25 cents per pound. This seems to us reasonable.

ONE of the most important mineral discoveries made on the Pacific Coast during recent years is that of several large masses of high-grade magnesite in the State of Washington, between the towns of Chewelah and Valley, 32 to 35 miles north of Spokane on the Great Northern railroad. The various deposits are from 8 to 13 miles from the railroad. They consist of interbedded masses, 200 to 400 feet wide, of coarsely crystalline magnesite lying bewteen quartzite and mica-schist. The magnesite is incased by a selvage of brucite, a magnesian hydroxide related to serpentine. An estimate of as much as 4,000,000 tons in one of the quarries, the Finch, has been made. The croppings extend for several miles. We understand that the whole group of properties has been acquired by Mr. D. C. Jackling.

SOME weeks ago we called attention to the wise provision by which cyanide from the works of the Cassel Cyanide Company of Glasgow was being supplied to the Canadian mines at 15 cents per pound. This, of course, was a war measure, under control of the British government, and was meant to insure continuance within the Empire of the precious metal production dependent upon this solvent. The question of cyanide manufacture is reviewed at some length in our Discussion department this week by Mr. James A. McRae. It is suggestive comment, and should lead to consideration of definite ways and means for assisting precious-metal mill-men in this country. Cyanide is necessary in facilitating the output of the metals needed in exchange, and fundamental to finance. It would seem pertinent to our own needs that cyanide production should also be regulated in America.

DETAILS of a simple, effective self-dumping arrangement for use in connection with skips, are given by Mr. H. Vincent Wallace in an article appearing in this issue. It is the kind of practical wrinkle that appeals to men in charge of mining. In addition to the safety and economy of the device, it is worth while to call attention, not only to the ease with which it can be manufactured in the shop at the mine, but to the tribute paid by Mr. Wallace to the skill of the Mexican blacksmith who made the one in use at the Nueva Luz property, and also to the efficiency of the workmen operating the appliance. This is in line with comment by other engineers, recently published in this paper, emphasizing the economic wisdom of utilizing native talent for practical mechanical operations conducted in foreign countries. To take ad-

vantage of such ability requires the right sort of spirit in the manager. Some persons never discover the latent talents in men of another race. To get a response in which he reveals the capabilities that lie within him, the manager must also be able to respond to the psychologic peculiarities of the employee, and this can never happen when the engineer in charge cherishes a disposition to depreciate his workmen for racial reasons or any other.

GOVERNMENT statistics show that the smelter production of primary copper in the United States during 1916 was 1,928,000,000 pounds, as compared with 1,388,000,000 in 1915, this being an increase of 39%—a huge gain. The difference in value is even bigger, the two totals being $474,288,000 and $242,900,000. Arizona was easily first with an output of 694,847,307 pounds and Montana second with 352,139,768 pounds. The apparent consumption of copper in this country during 1916 was 1,429,755,266 pounds, as against 1,043,461,982 the year before, this being an increase of 37%. If to the new refined copper is added the secondary copper and that in alloys produced during the year, it will be found that a total of over 2,000,000,000 pounds of copper was available for consumption.

WE note with pleasure that an American Committee of Mining Engineers in London has been organized "for assistance in the prosecution of the War." Among those instrumental in forming this committee were Colonel J. W. Boyle, Colonel Millard Hunsiker, W. B. Poland, R. Gilman Brown, D. P. Mitchell, Millard Shaler, Norman C. Stines, and Chester W. Purington, the last mentioned being honorary secretary. The purpose is to make such suggestions to the Government of the United States as may be useful in carrying on the War and "to offer the services of the committee for consultation and advice to representatives of the American government should this be desired." The idea has been received most courteously by the Ambassador, Mr. Walter Hines Page, in London. A sub-committee has arranged to go to Petrograd with the object of assisting in the organization of Russian railway transport.

Our Purpose

The statesmanlike opportunism of the President has been shown in many ways during the great crisis, notably by the speech made on Flag day, June 14. In paying an eloquent tribute to Old Glory he took the opportunity of informing our people why we have gone to war. His explanation will be convincing, not because Mr. Wilson is a student, or a professor of history, but because he is the President who was re-elected last November for the reason that "He kept us out of the War"—as long as he could—as long as the honor and safety of the United States permitted. His sincerity of intention is accepted and for that reason, among others, he is receiving generous support. The success of the Liberty Loan proves it; so does the general awakening of the popular intelligence to the realization of our concern in the calamitous events that have ensanguined the face of Europe, and some other continents also. Even now we are not fully awake to the intensity of their meaning, simply because physical distance obscures; for even the peoples of Europe, the British particularly, were slow to realize the bloody reality until it had been brought home to them by Zeppelin raids and by the wounded returning from the fighting on land and sea. We are facing the most stupendous crisis in all human history. "If the military masters of Germany succeed, they will be safe, but Germany and the world will be undone," as the president said; "if they fail, Germany is saved and the world will be at peace. If they succeed, America will fall with the menace." The German military machine was organized to make this earth impossible for any but the cogs in that relentless juggernaut of devastation. The world cannot remain "half slave and half free." Either the non-moral conscienceless domination of a military caste is to prevail and democracy be sent—where civilization is already—to the shambles, or the wrong-headed hysteria of a great people must be cured by defeat, and representative government emerge triumphant from the welter of war. "The world must be made safe for democracy or it will be rendered secure for military autocracy." A few months ago there were many who said "It is none of our quarrel; let us keep out of it." That seems long ago. A succession of maritime assassinations provoked our resentment, the enslavement of civilians in unhappy Belgium stirred our sympathy, the Zimmermann note shocked us into recognition of the sinister forces at work, not only to conquer Europe, but to threaten this continent. Then we realized that this was no European war. It is a world-war, a contest for the liberty of the nations on every continent, and more particularly for that freedom to live and let live which is the heritage bequeathed alike by the men that fought under Washington and by those that fought under Lincoln. The American idea is at stake, "the right of those who submit to authority to have a voice in their own government," we fight that "representative government shall not perish from the earth"; we fight also for "the liberties of the small nations, for a universal dominion of right by such a concert of free peoples as shall bring peace and safety to all nations and make the world itself at last free."

Truly we have a great cause. For more than two years we stood safely outside the great calamity; we prospered by the necessities of the fighting nations on the other side of the Atlantic; we took their gold until we were gorged with it; they jibed at our apparent gluttony; they sneered at our seeming timidity, but they are answered now. No nation ever risked its blood and its treasure so disinterestedly as the United States has done in coming to the aid of the Allies—now our Allies. Endangered we may be by German designs of overseas conquest, but not many of our people thought so when they put their hand into the President's and vowed to see this thing through. Our task is greater than self-interest and more glorious than self-defence. For human freedom and political liberty we risk everything; "To

such a task we can dedicate our lives and our fortunes, everything that we are and everything that we have."

The Miami Appeal

In our issue of June 2 we gave a telegraphic summary of the opinion of the United States Circuit Court of Appeals for the Third Circuit, at Philadelphia, in the case of Minerals Separation against the Miami Copper Company. This case had been appealed from the District Court of Delaware, at Wilmington, as our readers will recall. We published the text of the decision of the lower court in our issue of October 14, 1916. In our last issue we gave the majority opinion of the appellate court in full, and in this issue we reproduce the text of the minority opinion. The result, on the face of it, is favorable to the patent monopoly claimed by Minerals Separation, but, like the earlier decisions, it leaves large openings both for evasion and misunderstanding, and, like its predecessors, this latest judicial pronouncement presents points of disagreement with the various courts that have previously spoken. It will be noted that the majority opinion of two judges is vigorously opposed by the minority opinion of one judge. That Judge Woolley, who recorded the majority opinion, should not agree with Judge Buffington, who gave the dissenting opinion, will not surprise those that have read the record in the case, for the colloquies of these two judges with the various counsel disclosed, it seemed to us at the time, the trend of their thinking. The opinions are long, as if the judges desired to explain and defend their views. We shall not complain of that, because it is interesting to follow their ratiocinations. Judge Woolley goes into the technology of the subject and makes several obvious slips, which need not detain us. He, in voicing the majority opinion, interprets the Supreme Court decision in the Hyde case as meaning that "invention resides not alone in the critical proportion of oil, but also in air and agitation," or, as he expresses himself elsewhere, "in the co-action of the critical proportion of oil and air effected by 'an agitation greater than and different from that which had been resorted to before,' resulting in a froth concentrate of economical value." The learned judge must have meant 'economic.' The question therefore was whether the Miami practice was within the scope of the patent thus interpreted. The Supreme Court had established the validity of the patent, No. 835,120, but it "did not construe the patent or determine its scope." Minerals Separation claimed that the Miami operations were within the scope of their patent; the Miami company denied it. The Court of Appeals asserts that "the positions of both parties are extreme," and then makes the important criticism that "the contention of the plaintiff at least omits the very definite limitation of the patent to the results obtained by the use of oil with the described proportions [which, as our readers are aware, have been demonstrated, since then, to be non-essential and based upon a misunderstanding of the technology of the process], and also the equally definite disclosure of an agitation in violence and duration greater than before employed, while the defendant misinterprets words of description as words of limitation." This last refers particularly to the use, by the Supreme Court, of the phrase "by beating the air into the mass," when describing the agitation precedent to froth-flotation. Judge Woolley holds that the words quoted by the Supreme Court were not taken from the patent, but from the testimony of a witness for the patentees, and he proceeds forthwith to state his conclusion that the Supreme Court did not limit the agitation of the patent "to agitation by mechanical means," but to agitation of a violent and persistent kind. The agitation does several things, some old, some new. "It mixes the oil with the metal of the ore. This is old. Then, *by its greater intensity and longer duration,* it stirs the pulp into a froth." Here is the crux of the case; the agitation that is greater in intensity and longer in duration than anything heretofore used is the novel agitation of the patent in suit, by reason of which the Supreme Court upheld the patent. It is significant, and important to the art, that this decision of the Third Circuit Court of Appeals holds that the mixing of the oil with the mineral in the ore is old, because it leaves open the use of oil in connection with aeration-cells. The question therefore is whether the agitation produced in the Miami mill was of the prescribed violence and persistence. The defendant said that it was nothing of the kind, merely a gentle rising of air through the pulp "without any agitation whatever," claiming that "nowhere in the process is there agitation, or that, at most, there is only such agitation as appears in the prior art." As the Court says: "The controversy revolves around the elements of aeration and agitation." The Court then proceeds to consider (1) the use of the centrifugal pump, (2) the use of the Pachuca tank, and (3) the use of a break in the circuit. All of these three methods the Court holds to be the agitation in degree of intensity and time of duration of the patent, as defined by the Supreme Court. The Miami company was unfortunate in using the devices mentioned, for it is known now, and it was known before the case was first tried, that none of them was essential. Judge Woolley refers to the fourth method, in use at Miami, in which the Pachuca was not used, nor the centrifugal pump, only a bucket-elevator, but he ignores the fact, to which his attention had been drawn during the argument by defendant's counsel, because as he says, "we cannot consider and adjudge with propriety or authority a process with respect to which the plaintiff has had no opportunity to produce testimony and which was not embraced in the decree we are reviewing." Since the case was first tried the machines that appeared to the Court to necessitate violent agitation of the pulp have all been discarded, so that the decision is already out of date, just as the Supreme Court's dictum concerning the 'critical' proportion of oil was stultified, by technical practice in several mills, within a month after it had been promulgated. Having its eye on the centrifugal pump and the Pachuca tank (more properly called the

Brown agitator), the Court says: "When the critical [now mythical] quantity of oil is used and fomentation [or Fromentation] is produced by agitation, which in degree of violence and in duration is substantially that of the patent, clearly it is indifferent whether it is attained by mechanical or other means, for the patent deals with agitation as a means of developing the discovery, not with means for developing agitation." Hence the verdict on the issue of infringement; but the decision goes farther: it validates the use of the pneumatic cell in flotation. The Court says concerning the Callow cell: "Aeration is direct and is not the result of or caused by agitation. On the contrary, agitation results from aeration, and such agitation, though present in some measure, is not even approximately of the violence and duration of the agitation of the patent. The operations of the Callow cell certainly possess these distinguishing features from operations of the process where aeration is caused by agitation." On the next page of the opinion the Court confirms this important dictum by saying: "If the only agitation to which the pulp was subjected (after such agitation as in the prior art was necessary to mix the oil and ore) was the agitation of the Callow cells, we would not say that that agitation amounted to or was the equivalent of the violent agitation of the patent disclosure and constituted infringement." Apparently, if the Pachuca and pump had not been in evidence, the Court would have given a different decision. As it now stands, the Philadelphia decision clears the ground in that it leaves free the use of the Callow cell, in conjunction with such agitation as was used in the prior art solely for the purpose of bringing the oil in contact with the mineral; in other words, unless the use of the flotation process involves the use of an agitation characterized by great intensity and long persistence, as set forth in patent 835,120, it will not be held to infringe.

This interpretation of the majority opinion is sustained by the minority opinion, in which Judge Buffington states plainly that the case involves the question "whether any and all advance and improvement in the sphere of air flotation in mineral recovery for the next few years shall be subjected to what will practically be a blanket claim for any use of air as a flotation agency." He places himself on record squarely against anything of the kind, explaining why patent 835,120 should not be given the right to "paralyze the subsequent development of a great art." The patent, he says, does not give Minerals Separation the right "to monopolize all air flotation with a limited use of oil, but an unlimited use of agitation." The claim cannot be broader than the invention. That invention was based upon the quantity of oil, the character of agitation, and the resultant froth, but it is clear that the discovery, if it be such, is bottomed on a new kind of agitation that made possible a new extension of well-known properties of oil in a direction not reached by any previous methods of agitation. "The specification does not purport to disclose or to make use of any newly discovered property of oil. Let that be clearly understood," says Judge Buffington. "The oil required and used for covering or coating the mineral particles was precisely the same in quantity and function in prior practice and the practice of this patent. But what did happen was that the violence and duration of the agitation brought more particles into contact with oil than when the agitation was less violent." Elsewhere he says, "as the amount of oil was decreased, the amount of agitation had to be increased." What, then, was the disclosure? The Judge answers his own question by saying that it was the use of the Gabbett type of mixer, obtaining thereby the type of agitation essential to the process of the patent in suit. Thus it will be seen that the two opposing opinions of the Court are not so divergent as their verdicts would lead one to expect. If only the Miami management had not used the centrifugal pump and the Pachuca agitator in its early operations! But Judge Buffington says that, as the pump was discarded before the trial, no logical grounds existed for the patentees "planting themselves on the position that the pulp-lift of a centrifugal pump is air-agitation of their disclosure and claim." This minority opinion furnishes a powerful argument against Minerals Separation. Judge Buffington quotes the testimony of the three patentees to show how they laid stress on the "intentional beating in of air," and concludes that the basis of the invention was "agitation of a particular type and power," the use of which "led to the further discovery that all oil except the minimum required for mineral coating could now be dispensed with." Thus the so-called critical proportion of oil does not suffice to produce the process in suit; the Judge makes that evident: "That the invention cannot be based on the use of a minimum of oil alone is clear, for the stress laid on agitation in the specification and its presence as an element in the claim here in issue forbid any such holding, and the further fact that a claim based wholly on the use of a fraction of 1% of oil for coating minerals was abandoned during the prosecution of the patent." He points to the fact that Minerals Separation joined T. J. Hoover in applying for a British patent to use compressed air, and in that patent they themselves emphasized the difference between this method of introducing air and that described in patent 835,120. Therefore the Judge concludes that "the step of the process 'agitating the mixture until the oil-coated mineral matter forms into a froth,' meant the novel *air-entraining* agitation which the patentees disclosed, and did not cover the novel *air-releasing* agitation which the defendants disclosed." This is a notable pronouncement. It is not so much out of accord wth the majority opinion as at first sight appears, the main difference being that the Court's decision is based largely on the use of the Pachuca and the pump, a modification of the pneumatic method now no longer in use at Miami, whereas the minority opinion recognizes that this particular modification was nonessential. Both opinions support the contention that the Callow cell does not infringe the method of agitation described in patent 835,120.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Manufacture of Cyanide in America

The Editor:

Sir—The Slogan 'Made in America' appeals patriotically to everyone who has the welfare of this country at heart, and every effort should be made to promote and foster all industries that can earn success without penalizing other industries no less important. Throughout the western United States the matter of cyanide is of importance to many mining companies, and it is regrettable that the supply of this necessary chemical is not sufficient to meet the demand. At the present time prices being paid range from about 30c. to $1.20 per pound. The factors favorable to the starting of an industry in any new country are those that guarantee sufficiently low cost of material, also a steady demand for the finished article, adequate scope for a large output, abundance of experienced labor, and efficient management. Cheapness of power is also vital. The cheapest raw materials procurable are necessarily waste products from other industries, and in this matter the older countries have the advantage, and this is especially true when considering the manufacture of cyanide. Investigations of the scope for the industry reveal that in the United States and Canada the consumption of cyanide is quite large, although the advancement being made in the flotation method will tend to retard an increase in the demand. Details of the manufacture of cyanide on a commercial basis are not matters of public information, but descriptions of the main points are available in standard works such as Le Clerc's 'Cyanide Industry Theoretically and Practically Considered.' Here are descriptions of no fewer than 78 different processes for the manufacture of this chemical, indicating that, no matter what may be the handicaps, lack of variety of means available from which to make a selection is not one of them. It is interesting to know that the gold mines of the British Empire have been assured of an adequate supply, and also that in this era of high costs the price to all mines with contracts is the lowest that it has ever been. The Cassel Cyanide Co. of Glasgow, Scotland, after a venturesome and checkered career, has reached the distinction of being the largest producer of cyanide in the world. Founded originally as the Cassel Gold Extracting Co., Ltd., its primary object was to develop a gold-extracting process, invented by H. R. Cassel, and patented June 24, 1884. The process is described in the patent application as one for separating metals from ores and alloys, especially those of an auriferous character, by means of a solution yielding nascent chlorine under the action of an electric current. The merits of the process eventually became a subject of fierce controversy. Charges were made that it belonged to the 'gold from sea-water' variety, and the climax was reached when the inventor suddenly disappeared. Disappointed but not discouraged, the directors engaged John S. MacArthur, then holding a responsible position with the Tharsis Copper Co., to investigate the situation, and if possible relieve them from an embarrassing position. He did so by offering a process invented by himself and the brothers Forrest on May 14, 1889. This consisted in subjecting finely comminuted argentiferous ores to the action of a solution containing a small quantity of a cyanide. This is particularly interesting in view of the fact that the process originally intended for the treatment of argentiferous ore was applied only after a long time for that purpose on a commercial scale. The rest of the history of the Cassel company is similar to that of nearly all patent-owners. First, there were demonstrations of the efficiency of the cyanide process in the treatment of gold ores. Then followed plant installations in New Zealand and South Africa, followed later by installations all over the world. Demands were made for prohibitive royalties from users. These brought forth the usual crop of prosecutions for infringement, legal complications, favorable judgments alternating with those that were adverse, with a finally depleted treasury, company re-organization, and general dissatisfaction. Early in the career of the company the directors realized the importance of manufacturing cyanide in co-operation with their policy of pushing the development of the process, since the ruling price of the chemical was then 60c. per pound. A small factory was erected and arrangements entered into with industries from which the raw material could be obtained on advantageous terms. The prohibitive royalty for the use of the cyanide process, however, scared away prospective customers and the outlook became hopeless. A change in the administration gave rise to a new policy. The idea of collecting royalty, even in countries where the patent was upheld, was abandoned, and the efforts of the concern were directed toward developing the manufacture of cyanide. Antagonisms gave place to hearty co-operation and mutual help. This was the starting-point in the company's success. Mine operators bought the Cassel company's cyanide, and received the benefit of their technical experience. A good article was made and supplied at a price then considered reasonable. Business expanded rapidly, handsome profits were made, and a large cash reserve fund accumulated. In August 1914 about 70% of all the cyanide used in the British

Empire was, like so many other things, made in Germany. Stocks were low, and the Cassel company found itself confronted with the task of keeping British gold and silver producers in operation. That that task has been met successfully is a matter of congratulation alike to the company and to the Empire, as serious interruption in the production of the precious metal might have exerted an adverse influence on the prosecution of the War.

Although the Cassel company in later years has been highly successful, the history of many other cyanide manufacturing concerns does not yield such pleasant reading. During the last quarter of a century the vast strides made in gold and silver mining through the introduction of the cyanide process all over the world, as well as the demand arising from fumigating orange trees, has called into existence at least half a dozen new cyanide manufacturing concerns in Great Britain alone. Some of these companies obtained contracts from mines for supplies covering long periods at fixed rates, but practically every one of these new ventures met financial disaster. Liquidators' reports showed that lack of previous experience had proved costly, that several mistakes had been made for which remedies were needed, that the cost of raw materials had advanced, and that the market price for cyanide had declined. Small quantities of cyanide are manufactured spasmodically by some British gas companies when the quantity of waste by-products greatly exceeds the demand of more profitable markets. A few chemical works also produce cyanide on a limited scale, generally as an adjunct to the manufacture of other cyanide compounds, such as ferro and ferri-cyanides. The Cassel company owes its vitality primarily to having owned and developed the process, and to receiving, at the commencement of its manufacturing career, a high price for its product by which it made large profits, and extended the scope of its operation without increasing its capital, but its success in recent years appears to be due to sound financing, to associations with co-ordinate industries from which could be obtained the necessary cheap raw material, and finally to the great advantages accruing from experienced management.

From what little information is available on the manufacture of cyanide, it is evident that the most economical conditions of operation are absolutely necessary to make the industry pay. In deciding on a location for plant, the factor of transportation must receive first consideration. Thus, in gold and silver mining, the bulky material is the ore, which, looked upon as raw material, is used in quantities out of all proportion to that of supplies required for extracting the metal in a marketable form, and the cyanide accordingly must be brought to the ore. In cyanide-manufacture a situation for a plant should be selected in the neighborhood of abundant cheap raw materials, and of other elements necessary for production.

The three essential materials are sodium, carbon, and nitrogen, the last mentioned being necessarily in such a state that it will combine with the other two elements to form the compound NaCN. In Europe, at least two of these three elements are obtainable from the waste by-products of other industries and are therefore cheap. It would appear that the United States has reached a stage where by-products that can be classed as waste are available in commercial quantities, and if these materials are utilized, and a study of cyanide manufacture made, there would appear to be no reason why this substance should not be produced for home consumption at prices on a par with those existing in Britain.

Cobalt, Ontario, May 11. JAMES A. McRAE.

The Nature of Chromic-Iron Deposits

The Editor:

Sir—In your issue for April 21 is an article on 'The Nature of Chromic Iron Deposits,' by Samuel H. Dolbear. Mr. Dolbear's explanation of the origin of chrome deposits is probably correct for a large proportion of such occurrences, but there are many bodies of chromite of commercial importance that are undoubtedly fissure-fillings in the ordinary sense. There are many such in California, particularly in the northern part of the State. For example, in Del Norte county is a series or belt of fissure-veins running north and south through a large mass of serpentinized peridotite. These veins have the conventional characteristics of true fissures. The filling is talc and selvage with little or no quartz, and the ore occurs in the form of lens-shaped shoots. There are areas or zones in the belt in which the lenses are high-grade chromite, other areas in which the lenses are magnetite, and still others in which they are pyrrhotite and bornite. These last have been worked in past years as copper mines. The different ores are not entirely separate, because the chromite contains a small proportion of copper and iron minerals, and *vice versa*. Such deposits could hardly be formed by magmatic segregation as described by Mr. Dolbear. The copper ore was found to be unprofitable below a depth of 500 ft. The chrome ore was worked to about the same depth in places, and the mines were closed because of the cost of transportation to market. The principal chromite deposits in that district belong to the Tyson Chrome Co. of New Jersey. Similar occurrences of chromite are found in Siskiyou county, California, and have been worked recently.

JOHN B. PLATTS.

Hawthorne, Nevada, May 18.

MAYARI STEEL, made from the Mayari iron ores of Cuba, has been attracting increased interest. The ores contain nickel and chronium, and consequently form a natural alloy, which possesses greater hardness, tensile strength, and higher elastic limit than nickel steel, and also has a slightly greater elastic ratio and elongation. Below a tensile strength of 150,000 lb. per sq. in. the Mayari steel shows a greater reduction of area than ordinary nickel steel.

LONGITUDINAL SECTION OF THE BLACK OAK MINE, TUOLUMNE COUNTY, CALIFORNIA

The Black Oak Mine

By W. H. STORMS

This mine, in Tuolumne county, California, is half a mile south-west of Soulsbyville and is operated by the Black Oak Development Company. It was discovered in 1878 and has been worked almost constantly for twenty-three years. It is one of the most important and profitable mines in California. In the original group were several claims, but the company has since acquired large additional acreage, some of which is good agricultural land. The principal workings and mine buildings are on the Black Oak claim. The shaft is sunk on the vein and has reached an inclined depth of over 1800 ft., the lowest level being 1750. The vein has a somewhat varying strike, but is always a few degrees east of north. The dip, which is westerly, is variable, the extremes being 35 and 90°, averaging about 70° from the horizontal. The country is generally called granite, but the rock varies from place to place. In the middle portion of the developed ground, for a horizontal distance of over 1000 ft., the rock consists chiefly of quartz, feldspar (both orthoclase and plagioclase), and an abundance of hornblende, while mica is scarce. At both the northern and southern ends of the mine-workings, however, biotite is abundant, and quartz is an unimportant constituent. The rock presents all of the phases peculiar to the granitic areas of the Sierra Nevada foot-hill region.

Dikes of dark-green fine-grained diorite are numerous, particularly in the north half of the mine-workings. These dikes have a prevailing north-east strike, and stand at high angles. Some of them cut the granite in other directions, and the greater number appear to be older than the vein, or at least, to antedate the ore deposition, though there are exceptions. An effort to determine whether the granite had a strike in any common direction, disclosed the fact that such sheeting as could be identified had a strike in various directions, the most important being a few degrees west of north. East and north-east strikes were also observed. The region is one of much disturbance, which may be considered as contributing to the existence of the ore-bearing fissures.

The Black Oak vein varies in width from a seam to about 16 ft. It is said that in the old workings, above the 750-ft. level, it widened to 20 ft. Usually the hanging wall is well defined, but occasionally the ore is 'frozen,' and in some places the wall is rough and irregular. The vein exhibits a splicing-tendency, the ore occurring in overlapping wedges and lenses, with here and there a branch into the wall-rock. Several of these have been followed by drifts, but have usually proved disappointing at a short distance from the principal plane of fissuring. The ore is that common to the larger veins in granite, consisting of quartz impregnated with metallic sulphides, pyrrhotite being by far the most abundant. Pyrite and chalcopyrite also are present, though generally subordinate to the pyrrhotite. Galena and sphalerite occur more sparingly. Some of the iron sulphide is light colored, and is probably marcasite. All of these sulphides are auriferous, or, at least, are associated with gold, though an abundance of sulphides in the ore is not infallible evidence of high gold-content. The assay value of the ore ranges from $2 to over $100 per ton. The mill heads frequently assay from $50 to $80 or more per ton. One large stope averaged over $13 per

ton; another returned more than $23 per ton. Many tons of high-grade ore was shipped to smelters.

The structural features of the Black Oak vein are of interest. Several faults are exposed in the mine-workings, but only two are important, the others being of small displacement. The first fault discovered in the mine was cut years ago in the upper levels and it has been found on each succeeding deeper level that has been driven far enough to reach it. This fault has been named by the miners, 'the Slide.' Its strike is known only where exposed in the mine-workings in the vicinity of the vein, which it intersects at a low angle. The vein strikes 10 to 15° east of north, and the Slide strikes 15° more to the east. It also dips easterly at about 45° while the vein dips west. On each level where this fissure has been found it appears as a thrust or reverse-fault, that has displaced the vein and pulled the severed ends 50 ft. apart forming a band or zone along the plane of intersection of these two fissures, that, when plotted on a vertical longitudinal section, has a dip of 30° to the north. This zone of displacement usually contains some ore, due to 'drag' rather than to original deposition in this part of the fissure, for the rest of the 'Slide' fissure, so far as known, is not ore-bearing.

In the northern part of the mine is found what is known as 'the fault.' This is a normal dislocation that intersects the vein on its strike at an angle of 50° (strike N. 65° E.) The dip is southerly, but is variable, being 80 to 90° on the 1600-ft. level, and about 65° on the 800 and 1100-ft. levels. It was first found on the 800-ft. level 500 ft. north of the shaft. On each level it was found intersecting and displacing the vein in the same manner, but always at a point farther south. The former management of the property, in earlier years, did not understand the geological problems here presented, and whenever the fault was reached drifts were run on it on the supposition that it might be the vein, but no ore was found on the fault-fissure. Drifts were also driven straight ahead, on the course of the vein in the hard granite, but nothing was found in that direction either. After a time the mine was closed and it remained idle for some years. It was under the present manager, Roger C. Knox, that the vein was re-discovered by cross-cutting to the west through hard granite. This cross-cut was run normal to the strike of the faulted vein and in 110 ft. reached the fissure once more. The vein here has much the same appearance as south of the fault, but strikes more to the westward than south of the displacement. The fault-zone is several feet wide, consisting of two approximately parallel main fissures with numerous subsidiary fractures between. The granitic material is much crushed and altered, and in places has a gouge-like appearance, though this occurs locally.

This fault is the most important disturbance discovered in the mine, but its position, strike, and dip having been determined on every level between the 800 and 1800-ft. levels, it is no longer a source of uneasiness in planning the development, though it entails additional expense in running the cross-cuts through the granite, which is exceedingly hard. Each cross-cut is over 100 ft. long. North of the fault, which for many years had been thought to end all profitable mining in that direction, the present owners have stoped a body of ore 500 ft. long, over 500 ft. high, and from 2 to 16 ft. wide. This body of ore yielded a handsome profit. Below the 18th level for its full length it is still unstoped. In addition to this ore-shoot, the entire region of mineralization south of the fault has possibilities below this present lowest level of the mine.

As an example of the somewhat erratic occurrence of ore in the Black Oak mine, a long drift had been driven on the vein south of the shaft, on the 10th level. Some stoping had been done above but had been discontinued. South of the shaft, 630 ft., at a place where the vein was thin, a small quantity of ore was found in the back. A raise at this point showed decided improvement at a height of 40 ft. Three days later a face of ore 4 ft. wide was exposed 30 ft. long that assayed nearly $20 per ton. The ore, however, continued upward only a few feet and work there was discontinued. The 10th level remained idle thereafter until the fall of 1914 when a winze was sunk 545 ft. south of the shaft, following a small stringer of ore, to a depth of 60 ft. A drift south at a distance of 100 ft. from the winze cut the downward extension of the ore that had been found nearly a year previously in the raise above the level. The ore in the raise lay immediately under the smooth hanging wall, but where a drift was started north on this shoot, the ore left the wall and extended into the foot, departing 25 ft. from the wall in driving 100 ft. The ore was not particularly rich, but with the best ore in the new vein always opposite the richer ore next to the hanging-wall vein. This unusual condition continued for 250 ft. The ore extended northward to a point 84 ft. from the shaft, where the foot-wall vein abruptly turned to the east and the ore disappeared. The foot-wall vein dips 55° west, while the hanging-wall vein dips 70° west. The two veins unite 90 ft. below the 10th level, and contrary to the common belief that the union of two veins should produce a bonanza, the junction of the veins in this instance was disappointing, as the ore was neither abundant nor rich. A raise was driven above the 13th level beneath the winze on the 10th level, to search for this new shoot, and it was cut 100 ft. above the 13th level where rich ore was found, continuing without interruption to the 10th level.

This new and unexpected ore-shoot, discovered where no ore was supposed to exist, was stoped 400 ft. high and 300 ft. long, and produced $250,000. It illustrates the vagaries of veins of ore in granite. It is interesting to note that this ore-shoot, as well as all others in the Black Oak mine, occurs entirely under the hills, and that little or no ore has been found beneath Curtis creek or any other depression that crosses the vein.

At the north end of the mine, on the 15th level, the fissure has been followed a long distance beyond the north end of the ore-shoot north of the fault. It is persistent, though small. It shows no ore, and the formation has changed. For some distance the fissure cuts through

a dike of diorite, then enters a hard silicious rock, resembling alaskite, dark-gray in color, due to inclusion of some dark-colored mineral. On passing beyond this unusual rock, no trace of which was found elsewhere on the surface or underground, the fissure continues in the granitic rock, which here contains much biotite as well as hornblende, but with only a few quartz granules. Prospects for ore in this direction appear discouraging.

The metallurgy of the Black Oak ores was for years a serious problem and thousands of dollars were spent in experimenting. The old company succeeded finally in obtaining a high extraction, but was unable to recover the gold and silver from the sludge. The filter solved the problem. The ore now is crushed by stamps in cyanide solution, the pulp going to Dorr classifiers; the fine to Dorr thickeners and the coarse to a tube-mill, where it is ground to 200-mesh; this also goes to thickeners, and with the fine from the first thickeners goes to three Pachucas connected in series. From the Pachucas the solution goes to an Oliver filter. Clarifying and precipitation-presses do the rest. The 20 stamps crush 80 tons per day. The actual saving averages 97%, and sometimes exceeds it. A new compressor has lately been added to the surface equipment; also a saw-mill having 5000 ft. daily capacity. The tailing is now being impounded.

THE BLACK OAK STAMP-MILL AND CYANIDE PLANT

At the south end of the Black Oak property and forming a part of it is the Live Oak claim, where rich ore was discovered at the surface many years ago. A shaft was sunk there on a vein two feet wide, the ore running about $25 per ton in gold. After an idleness of years the mine was re-opened and some very good ore mined. The 10th level of the Black Oak has been extended into the Live Oak, and good ore discovered on that level also.

The property of the Imperial Mining Co. adjoins the Black Oak on the north and comprises a tract of 160 acres, being what was formerly known as the Landers ranch. There are numerous veins traversing the granite of this area, the Black Oak vein striking through it in a north-south direction, and the west branch of the Soulsby vein entering the ground near its north-east corner. The long drift on the 1500-ft. level of the Black Oak mine runs several hundred feet under the Imperial area, but is protected in this by extra-lateral right. The Imperial company has had numerous pits sunk on outcrops upon its property, and is now sinking the Harry and Landers shaft on the Black Oak vein, where a good prospect has been discovered. Nothing has yet been done on the Soulsby vein in this property, and further prospecting will be necessary before any extensive or permanent development is there undertaken. The Soulsby mine has been one of the most profitable mines in the State, having a record of $6,000,000 produced, a large part of which was profit.

Joining the Live Oak on the south is the Yost ranch, on which is the Junction mine, where a shaft, said to be 300 ft. deep, was sunk in 1896 to 1898. Some very good ore was found in a small shoot 70 ft. from the surface, but the development as a whole proved disappointing, and work was discontinued. The vein is thought by some to be the southerly continuation of the Black Oak-Live Oak vein, but if this be so there must be a displacement of 200 ft. or more, due to faulting. This has not been determined. From the Junction vein, which strikes north-south, there are several veins branching from the main fissure. These branches all have a north-east or south-west strike, some on the east side and others on the west side of the principal vein. These branches in places carry rich ore, $100 per ton and over, but the veins as a whole are too low-grade to be mined profitably. One of these veins is separated by horizontal floors with spaces an inch or two wide that are filled or partly filled with clay and crushed fragments of quartz. The material between these floors always contains gold, far above the vein rock itself in value.

Fixation of Nitrogen

Both for plant-food and for the manufacture of explosives it is necessary to produce nitrogen in a 'fixed' form. Nitrogen is readily fixed by the action of certain bacteria, known as nitrous and nitric bacteria (Nitrosomonas and Nitrosococcus), which are present in soils in all parts of the world. These are responsible for the nitrification of soils without which plant-life would dwindle and disappear; but intensive agriculture, with removal of the products for consumption elsewhere, depletes the soil of its fixed nitrogen, and this must be replaced by fertilizers. It has been assumed by some investigators that nitro-organisms were responsible for the accumulation of nitrates in the desert of Tarapacá, Chile, but it is doubtful whether this agency has been more than feebly contributory to the formation of the great deposits of sodium nitrate which are found in that region. It is more probable that it is a result of direct combination between original magmatic nitrogen occluded in the volcanic flows and tuff and the nascent hydrogen evolved in the formation of magnetite as one alteration product in the rock, as pointed out by De Kalb (M. & S. P., May 6, 1916). In the United States there has been almost complete reliance upon these natural Chilean resources, while great efforts have been made in Europe to develop artificial means of fixing nitrogen to an economic stage. This has been accomplished in various ways. The United States Government last year appropriated $20,000,000 to establish a hydro-electric plant for producing fixed nitrogen. We have dawdled as is our wont, and the plant is not even yet under construction. Meanwhile great plants are being erected abroad, and recently one was started in Sweden to utilize the Birkeland-Eyde process, and to be ready within the current year. We might have had similar works in operation had the business been conducted with military concentration of purpose. Instead, we have squabbled over the merits of the constituencies bidding for the establishment of the nitrogen pork-barrel in their midst, and have listened to complaints that we were lacking in knowledge of the economies of the various processes, while the Teutonic hindering policy was insidiously introduced under the guise of learned scientific quibbling.

The cyanamid process, however, has been successfully developed at Niagara Falls, and is more readily available for introduction into new plants, where cheap hydro-electric power can be obtained promptly, than any other method. The accumulated experience in its manufacture in this country is also strongly in favor of its immediate application. Frank S. Washburn of the American Cyanamid Co., one of the ablest electro-chemists in the world, has cogently argued for the instant application of this process by our Government, and the proposal made is a patriotic one, involving no high-priced monopoly. For the benefit of those who may not be familiar with the cyanamid process it may be stated that calcium carbide is first made from lime and carbon in the electric furnace. The carbide is then finely ground and the powdered material charged into another electric furnace of special design where it is maintained at 1000° C. Pure dry nitrogen, produced either by the copper oxide or the Linde process, is then passed over the hot carbide and is there absorbed. Starting with a carbide containing about 80% of that compound, from 80 to 90% of the theoretical quantity of nitrogen will be absorbed. The product is a grayish-black mass of cyanamid ($CaCN_2$) mixed with calcium carbide and lime. It contains about 20% nitrogen. If this be treated with superheated steam the nitrogen is disengaged from the cyanamid in the form of ammonia, which can then be oxidized by the Ostwald or other processes to nitric acid for use in the manufacture of explosives. Sodium cyanide may also be made from cyanamid by fusing it with common salt.

Mr. Washburn's comments, given at length in the *Oil, Paint and Drug Reporter,* afford interesting comparisons between the competing processes for the fixation of nitrogen, which are of great significance in view of our extraordinary need of this vital resource. He says: "The arc-process requires for the fixation of a unit of nitrogen between five and six times as much power as is required by the cyanamid process. For the production of 180,000 net tons of concentrated nitric acid per annum, 540,000 continuous horsepower is required by the arc-process and 100,000 continuous horsepower by the cyanamid-process, which at $100 per horsepower installation-cost is the difference between $54,000,000 and $10,000,000. The total installation-cost of the arc-process is excessive compared with the installation-cost of the cyanamid-process, particularly where the cost of developing power is not extremely low. With the cost of power-installation at the modern American figure of $100 per continuous horsepower on the switchboard, a plant for 180,000 net tons of concentrated nitric acid per annum by the arc-process would cost $80,000,000, and under the same conditions a plant for the same capacity by the cyanamid-process would cost $30,000,000. For the production of fertilizers alone the disproportionate cost of plants of equal capacity is much greater than indicated by the figures above for the production of nitric acid. Concentrated nitric acid by the arc-process, taking the installation-cost of power at $60 per continuous horsepower on the switchboard, costs per ton to produce one-third more than by the cyanamid-process. This disproportion is, of course, correspondingly greater where the cost of power-installation is $100 per continuous horsepower. The disproportion in the cost of producing equivalent quantities of nitrogen in the form of fertilizer alone is greater than for nitric acid. Even with power at what would be an abnormally low figure in the United States, namely, a $10 operative cost per continuous horsepower on the switchboard, the pound of nitrogen produced by the arc-process costs for power alone as much as the total cost of the pound of nitrogen by the cyanamid-process, including power, materials, labor, interest, amortization and depreciation. The Haber process does not seem to have found an advocate in the present controversy, as far as known. The process is protected by United States patents."

The Miami Appeal

Minority Opinion of the U. S. Circuit Court of Appeals, Philadelphia

BUFFINGTON, J., dissenting:

Putting aside all minor incidents, this case in my judgment, involves one broad, basic and far-reaching question, and that is whether any and all advance and improvement in the sphere of air flotation in mineral recovery for the next few years shall be subjected to what will practically be a blanket claim for any use of air as a flotation agency.

The claim which we are asked to construe and apply is for:

"The *herein* described process of concentrating ores, which consists in mixing the powdered ore with water, adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of one per cent. on the ore), agitating the mixture until the oil-coated mineral matter forms into a froth, and separating the froth from the remainder by flotation."

I say, putting aside all minor incidents, for it is perfectly clear that if all kinds of air flotation and all kinds and degrees of agitation are covered by this claim, the infringement of the defendants is self-evident by their use of compressed air which produces some agitation and causes air flotation. To my mind, and for reasons I shall now discuss, this claim should not be awarded this sweeping scope which will paralyze the subsequent development of a great art.

Now, if any broad right to monopolize all air flotation with a limited use of oil but an unlimited use of agitation exists, it arises by virtue of a contract made between these patentees and the government, and that contract is embodied in the claim of the patentees, made by them and conceded by the government, the other of the contracting parties, and the consideration for that claim is the required statutory disclosure made by the patentees:

"* * * of the manner and process of making, constructing, compounding, and using it, in such full, clear, concise and exact terms as to *enable* any person skilled in the art * * * to make, construct, compound and use the same * * *, and he shall particularly *point out* and *distinctly claim* the part, improvement, or combination which he claims as his invention or discovery."

Turning now to the patent itself, which has been held valid and described by the Supreme Court as "patentable, as new and original as it has been found useful and economical," let us inquire first what was the new thing disclosed, for therein we have the consideration for the claim; and second, what claim was allowed in consideration of such disclosure. This line of approach, is, to my mind, imperative, first, because while an invention may be broader than a claim, a claim can never be broader than an invention. Finding from this claim that it concerns two things, oil and agitation, we must necessarily turn to the specification and there ascertain what was the new disclosure as to oil and agitation. In substance, it was the disclosure of a process in which a hitherto unused minimum of oil and a hitherto unused maximum of agitation were used. Each of these disclosures was summed up by the Supreme Court in these words:

"The process of the patent in suit, as described and practised, consists in the use of an amount of oil which is 'critical,' and minute as compared with the amount used in prior processes 'amounting to a fraction of one per cent. on the ore,' and in so *impregnating with air* the mass of ore and water used, by agitation—'*by beating the air into the mass*,' as to cause to rise to the surface of the mass, or pulp, a froth, peculiarly coherent and persistent in character, which is composed of air bubbles with only a trace of oil in them, which carry in mechanical suspension a very high percentage of the metal and metalliferous particles of ore which were contained in the mass of crushed ore subjected to treatment. This froth can be removed and the metal recovered by processes with which the patent is not concerned."

It will thus be seen that, first, the quantity of oil, secondly, the character of agitation, and, thirdly, the resultant froth, constituted the disclosure. Apart from the authoritative statement of the Supreme Court as to what was the invention of these patentees, which of course controls us, it is clear both from the proofs, the physical facts and a general knowledge of the art, that such was the case, and that this discovery is bottomed on agitation—the new kind of agitation disclosed—which made possible a new extension of well-known properties and capacities of oil into fields oil had not reached by any previous methods of agitation. And it follows that if agitation of maximum character is the dominating factor that made possible the use of a minimum of oil, that claims which specify the use of oil and of agitation must not be read in a way that ignores the new and disclosed agitation, which was not only the only specific agitation, but the only generic agitation the patentees disclosed. For it is perfectly clear that if the art of air flotation today had stopped where the disclosure of this specification left it, that the only method of air flotation would be the agitation disclosed in the patent. The specification does not purport to disclose or to make use of any newly discovered property of oil. Let that fact be clearly understood. That oil had three qualities was well known prior to this patent—first, that oil had an

affinity for metal particles; secondly, that the oil covering the metal was of infinitesimal thinness; and, third, that oil has no affinity for and will not coat gangue. Such being the known action of oil, viz.: its affinity and its capacity for thus thinly coating it and for not coating gangue, it is manifest that whenever oil, gangue and metal particles are mixed only a minute quantity of oil was needed to coat and actually did coat the mineral particles. The larger quantities of oil used were not needed or used to coat, but to float, the minerals. These facts are proved by the testimony of Sulman, hereafter quoted and alluded to in the House of Lords opinion, referred to later as an agitation which "assists the process of minute quantities of oil reaching minute particles of metal." But while the small quantity of oil used as a metal covering was a fact, the significance of that fact was not recognized in the preceding practice, for the manifest reason that in such art there was no use of oil alone for metal covering purposes, but it was used for the double purpose, first, of oil covering, and second, oil flotation. When, therefore, the patentees disclosed a process in which the oil necessary for flotation was dispensed with, the requirement of a small amount of oil for purely coating purposes became at once apparent and assumed a new significance. This was referred to by the Supreme Court when, in distinguishing it from the prior art, it said:

"The small amount of oil used makes it clear that the lifting force which separates the metallic particles of the pulp from the other substances of it, is not to be found principally in the buoyancy of the oil used, as was the case in prior processes," etc.

From these considerations it will be seen that oil required and used for covering or coating the mineral particles was precisely the same in quantity and function in prior practice and the practice of this patent. But what did happen was that the violence and duration of the agitation brought more particles into contact with oil than when the agitation was less violent. What, then, was the disclosure? This is clearly shown by the patentees in their specifications, where they show the *nature of their improvement* by contrast with the prior practices of the Cattermole patents. These proofs show that the present discovery was made while working on the process disclosed by Cattermole and the specification recites its relation to Cattermole. Turning, therefore, for information to Cattermole's patents, I find Cattermole's process was one where oil was used for the double purpose, viz.: First, such small quantity as was necessary for metal particle covering; and, second, such large quantity as was necessary for metal particle flotation. I say "for metal particle flotation" advisedly for, while the process finally ended in the metal particles finding their way to the bottom and the gangue to the top, yet as a necessary precedent step to making the metal particles go to the bottom, they were first floated upward, so as to enable them to *there* nucleate or agglomerate in such numbers that their combined weight overcame the buoyant capacity of the oil and they sank to the bottom of the vessel. These several actions are set forth by Cattermole, as follows:

"The invention depends upon the application of the following facts: First, when a mixture of powdered metalliferous matter and gangue is treated with oil suspended in water—that is to say, in emulsion—*the oil has more or less selective action and will coat the particles of metalliferous matter in preference to the particles of gangue,* while the particles of gangue will be wetted by the water; second, if the water which is mixed with the oil is acidulated with mineral, fatty, or other acid the *selective action of the oil will thereby* be rendered more marked and decisive; third, if the proportion of oil is kept within reasonably low limits (differing in different cases, according to the nature of the mineral to be treated and the consistency and nature of the oil) and if the mixture of water, oil, metalliferous particles, and gangue be *thoroughly agitated* the metalliferous particles which have become coated with oil will adhere together and form granules, which granules, partly by reason of gravity and partly on account of their bulk, as compared with the individual grains of gangue, will offer ready means for separation in an upcurrent separator, a jig, or other similar appliance."

At this point it should be noted that as the patentees, in order to explain their disclosure, by reference make the Cattermole patent part of their specification, as the agitation used by the patentees was a step in the Cattermole process and the Supreme Court found the patentees used and disclosed "an agitation greater than and different from that which had been resorted to before," and also that "the extent of the agitation of the mass had been increased as the experiments proceeded until the series of the Gabbett mixers, fitted with the usual baffles, were speeded at from 1,000 to 1,100 revolutions per minute," an inquiry into the character of the new kind of agitation used and disclosed by the patentees becomes essential to a due understanding of the disclosure made. As recognized and stated by the Supreme Court, this agitation consisted in the patentees speeding up a Gabbett mixer to ten or eleven hundred revolutions per minute. The extent of the agitation of the mass had been increased as the experiments proceeded until, as stated by that Court, the "series of Gabbett mixers, fitted with the usual baffles, were speeded at from 1,000 to 1,100 revolutions per minute." It is apparent that this tremendous agitation speed through a mushy substance like pulp could only be reached by some special appliance impelled by powerful mechanism since no ordinary paddle mechanism could stand the strain and furnish the power to meet such a requirement. We accordingly find that this was done by the patentees speeding up to hitherto unused speed the device known and used in Cattermole's process. Instead of seeking to move the whole pulp mass by rotating paddle pressure on the whole mass—a thing which, owing to the length of the paddle required would be impossible, Gabbett, as shown by his patent No. 444,345, segregated a part of the pulp. This segregated part alone he moved by paddles and

thereby set up a centrifugal force in the pulp in such segregated section, and thus made the centrifugally moving pulp itself the agency for moving the pulp on the outside of this inner dividing vessel. His device was built in two forms, one of which expelled the pulp at the top and the other at the bottom. Referring to the top expelling device, shown by Figure 1, which, as we shall hereafter see, these patentees necessarily declined to use, its operation is as follows:

"A is a conical shell, having internal ribs A^2 and mounted on a shaft B, by which it is suspended within the vessel or tank C, containing the liquid to be acted upon, the shaft being carried at its upper end by a bracket D and guided by a bush or stuffing-box E on the cover of the vessel C. Assuming this vessel to be charged with liquid to the level indicated and the shell A to be rotated by suitable gearing, such as indicated at F, then the body of liquid within the shell being carried round with the same by means of the ribs A^1, the centrifugal force will cause the liquid to rise along the inclined inner surface of the shell and to be ejected into the surrounding liquid when arriving at the upper edge thereof, while at the same time the pressure of the surrounding column of liquid in the vessel C will cause fresh quantities of liquid to enter the lower end of the shell A to make good the quantity discharged at the top. Thus a continuous circulation and consequent mixing of the liquid will be effected, as indicated by the arrows."

That is, the machine discharged at the top. Its paddles, being submerged in the segregated pulp, it could not beat in air. But neither Cattermole nor the patentees who adopted Cattermole, used the top *outlet* type of Gabbett's device above described, but did use the other or top *inlet* type shown in Figure 9, although both moved the pulp in the same way, but in opposite directions.

Selecting the top inlet or cone type shown in Figure 9 of Gabbett's two forms, although both machines and agitators were, with the exception named, counterparts, there was a functional advantage in the top inlet type used which was vital to the working of the present patentee's process. And that there was a functional disadvantage in the top outlet type which would have been fatal to the working of their patent will, for reasons hereafter stated, be made clear. The only point now made is that the agitation, and the only agitation which the patentees disclosed as embodying the agitation of their process, was an agitation of one of two particular kinds, namely, one where they utilized their agitation power on a small zone of *segregated pulp*, and where, for functional reasons, as we shall hereafter see, they applied such agitation to this segregated pulp as it was traveling in one direction, that is, downwardly. At this point we recall, as before stated, that Cattermole's object was to nucleate or agglomerate into a mass the individual oil-coated mineral particles, or, as summarized by the Supreme Court, "agglomerating the oil-coated concentrate into granules heavier than water, so that they will sink to the bottom of the containing vessel." As stated in the patent, "the more oil is used the larger, softer and less numerous the granules." It was in the use and experimentation of this process that the discovery of the patent in suit was made, and these experiments were duly reported (see Vol. 4, p. 22 and following) from time to time. From these reports it will be seen that the agitator used was of the cone-shape, upper-intake type already described and shown in Figure 9. By March, 1903, they found the value of both violent and protracted agitation; and that such protracted and violent agitation was effective to coat the mineral particles with oil. "Somewhat *violent* agitation is now required for a *few minutes;* the time being *dependent* upon the *efficiency* of the agitation, and varying from two to five or eight minutes, *whereby* the oil is released from the gangue and *attaches itself exclusively to the mineral.*" Later, that is, in March, 1914, when a speed of 988 cone revolutions was reached, and the effect of agitation effecting air-flotation was noted, where, under the head of "Flotation factor used," it was said:

"* * * the coarse sands when passing through the last two mixers were allowed to be *beaten well with air* by keeping the liquor low in the mixers and using fast agitation, with baffles in. The concentrates were then found to be floated *up* in the outcast if only a general up-current were used."

The italicising of the words "and" and "up," the phrase "beaten well with air" and "fast agitation," show that the significance of violent agitation and the entraining of air was in the path of experimentation following the basic feature of the subsequent disclosure of the specification. In March, 1905, under the head "Influence of peripheral velocity of cone"—and it must not be overlooked that "cone" was the word which described the inlet top (Fig. 9) of the Gabbett mixer—it was said, "An increase in the peripheral velocity of the *cone* causes a decrease in the time required for granulation, a point being reached after which this decrease is slight." From this entry it will be seen that increase of agitation was still regarded as and was the factor which was leading toward the discovery afterwards made and disclosed in the specification. In the next report both the speed and the type of Gabbett's agitation is again emphasized by contrasting:

First.—The low speed of the Gabbett as useless;

Second.—The Gabbett *cone* mixer alone and with baffles added as an additional agitation agency;

Third.—The inability of a centrifugal pump speeded higher than a Gabbett mixer to furnish the agitation requisite.

These points are all outlined in said report as follows:

"*The influence of the speed and type of agitation* becomes a factor of great importance to our recent experiments. Speeds of rotation (with a small Gabbett) varying from 3 to 500 revolutions per minute, *proved almost useless.* This shows the necessity of high speed agitation."

Continuing, the report said:

"We then made a series of baffles which were placed

in the Gabbett and which were 'solid,' *i. e.*, they occupied the *greater free space* of the Gabbett vessel from the glass sides up nearly to the working surface of the cone. They were found to be disadvantageous as they gave *too violent* agitation, and set up large eddy currents in front of each baffle, greatly reducing rotation speed of the liquor in the Gabbett and adding *water friction* to such an extent to the rotating cone, that the power required to drive the latter was more than doubled. On replacing these solid baffles by the *ordinary type of thin rod baffles,* the granulation period was much improved, and the power consumed in driving the cone fell again to the normal."

This, to our minds, shows that although the baffles increased the agitation, they precluded the kind or quantity of agitation desired. Manifestly the stoppage and delay of the pulp in eddies caused by the baffles, stopped the steady and more frequent passage of the pulp through the cone and this lessened the amount of agitation in the segregated zone where the air was beaten in.

Continuing, the report adds:

"We have also carried out a series of experiments with a small centrifugal pump in place of a Gabbett, to determine whether this gives a better form of agitation than the cone. * * * The following figures were obtained by Mr. Leechman yesterday in comparison with the Gabbett, and show the latter to be distinctly preferable to the centrifugal pump experiments. We may say the centrifugal pump used was only a small one, having about a 4½ to 5" chamber, but it was speeded up to about 1,200 *revolutions per minute. The pump, therefore, had a considerably higher peripheral speed than* the Gabbett used in parallel tests."

From this it will be seen that by a process of elimination it was becoming evident that the agitation desired was only obtainable on a *cone* or *top inlet* Gabbett mixer, and that the violent agitation by solid baffles and by the higher speed of a centrifugal pump were both objectionable.

In the light of subsequent events, it is quite evident why this was the case. In the first place, the top inlet or cone Gabbett mixer, by the rapidity of revolution, formed a hollow air chamber around the shaft, into which air was drawn down and was there beaten by the paddles into and aerated the pulp. It is also clear that if solid baffles were used on the sides of the outer chamber, the rapid flow of the pulp would be measurably stopped and it could not pass as often through the cone, and therefore was not subjected to as much air beating as when the baffles were not used as manifestly all the air beating in took place in the cone. And lastly, while in the Gabbett mixer the revolving paddles in the cone were able to strike and beat the air into the surrounding pulp, it is evident the blades of the centrifugal pump, *being necessarily wholly immersed in pulp,* had no contact with air or an opportunity to beat air in. In other words, by its blade submerging, the centrifugal pump had no more power or opportunity to beat air into the blade-enveloping pump than would have been the case had the paddle blades of a Gabbett mixer with a *top outlet* (see Figure 1) whose blades would also be wholly immersed in the outflowing stream, been used.

It will here be noted that as the centrifugal pump was the sole form of agitafion used in this particular stage of the experiments, and as it was discarded by the experimenters, that, tested by the acts of these patentees, no logical grounds existed for their counsel now planting themselves on the position that the pulp lift of a centrifugal pump is the air agitation of their disclosure and claim.

In the next report, March 16, under the head "Influence of the percentage of oil," we find the effect of oil reduction is noted:

"The effect of diminishing the percentage of oleic acid is to alter the type of oiling; the higher percentages producing granules, and the lower froth. Six per cent. of the oleic acid on the mineral is sufficient to form good granules without much froth. * * * 0.62% oleic acid on the mineral is insufficient to form any granules and nearly the whole of the mineral comes to the surface on stopping the cone, as froth."

It will be thus seen that it was agitation, and agitation of a selected type and speed, that gradually led up to the May 3, 1905, report, where the invention was definitely recorded. And when this was done it was accredited to the agitation indicated. That report says:

"We beg to hand you herewith a statement of the new method of oil concentration which we have been engaged in investigating and working out in detail, for the purpose of your forwarding to Mr. Courtney and his staff in Australia. It will be best to start with a short statement of the principle on which the process depends. In determining the lowest limit of oleic acid which could be employed in granulating, it was found that granulation practically stopped at a range of about 0.5% of oleic acid on the mineral (60 mesh Broken Hill), in an acid circuit somewhat below 1% in strength. A certain amount of black mineral froth was, however, noticed as a result. On successively decreasing the amount of oleic acid *below* 5% it was found that whereas granulation ceased there was a growth in the amount of mineral float-froth under these conditions, and that the production of such float-froth appeared to reach a maximum when about .1% of oleic acid on mineral was used. This froth on collection was found to consist of oiled mineral slimes *mechanically holding more or less coarse* (oiled) mineral particles, the froth carrying between 70 to 80% of the total mineral present in the charge." * * * "The froth produced is not due to any action of the acid circuit upon traces of calcite present in the ore, *i. e.*, not to the liberation of any gas in the charge by means of the dilute acid employed in the circuit. It has been located, on the contrary, *to the aid introduced by the Gabbett cone during agitation, the air attaching itself to the oiled mineral slimes and to a large proportion of the coarse mineral particles, although both these materials can only be coated with an infinitesimal amount of oil, i. e.*, oleic acid. That the formation of froth is due to *air inclusions during the agitation,* and not to carbonic acid or sulphur-

etted hydrogen is proved by the following experiences:" * * * "The plant consists of a series of Gabbett mixers fitted with the usual baffles, and speeded at from 1,000 to 1,100 revolutions per minute as regards the cone. These Gabbett mixers are identical in every respect with those used for the original Cattermole process. * * * The operations are therefore summarized as follows: *Gabbett agitation* in the usual way with .1% oleic acid"—

thus themselves coupling with their invention at its birth the name of Gabbett and Gabbett agitation, which they now seek to avoid.

This terse and complete summary of the discovery in "*Gabbett agitation* in the usual way with .1% oleic acid," is also the summary of all that is set forth in the specification of the patent in suit, and further and other than "Gabbett agitation in the usual way with .1% oleic acid" the long specification discloses no method or suggestion of other agitation, and gave none to the art. Such specification starts with reference to the Cattermole patent from which we have quoted, No. 777,273 and 777,274, and states that in the former—

"Oil varying from four per cent. to six per cent. of the weight of metalliferous metal present is agitated with an ore pulp so as to form granules which can be separated from the gangue. * * * We have found that if the proportion of oily substance is considerably reduced—say to a fraction of one per cent. on the ore—granulation ceases to take place, and after vigorous agitation, there is a tendency for a part of the oil-coated metalliferous matter to rise to the surface of the pulp in the form of a froth or scum."

Such was the discovery the patentees embodied in the two claims here in issue, viz., Claim 1:

"The herein-described process of concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of one per cent. on the ore), *agitating the mixture until the oil-coated mineral matter forms into a froth, and separating the froth from the remainder by flotation.*"

And Claim 12:

"The process of concentrating powdered ore which consists in separating the minerals from gangue by coating the minerals with oil in water containing a fraction of one per cent. of oil on the ore, *agitating the mixture to cause the oil-coated mineral to form a froth, and separating the froth from the remainder of the mixture.*"

It will be observed that these two claims do not themselves cover any complete, workable process of concentration disclosed in the specification, but are separate steps or elements in the process of workable concentration described in Claim 3, which, in addition to the above elements, includes the elements of acid and heat. And that the extract quoted above, embodied in Claims 1 and 12, was not a complete concentrating process, but merely certain elements or steps of it, is made clear by the patentees, for, after reciting that "there is a tendency for a part of oil-coated metalliferous matter to rise to the surface of the pulp in the form of a froth or scum," they add:

"This tendency is dependent on a number of factors. Thus the water in which the oiling is effected is preferably slightly *acidified* by adding, say a fraction of one per cent. up to one per cent. of sulphuric acid or other mineral acid or acid salt, the effect of this acidity being to prevent gangue from being coated with oily substance, or, in other words, to render the selective action of the oil more marked. * * * Again, we have discovered that the tendency for the *oily substance to disseminate* through the pulp and the rapidity with which the metalliferous matter becomes coated is increased as the pulp is *warmed.*"

It will thus be seen that the workable concentration process which the patentees gave the art, was one in which the "flotation of mineral particles" was dependent on a number of factors, viz., first, Gabbett agitation; secondly, .1% of oleic acid; thirdly, .1% sulphuric acid, and fourth, heated pulp. And the workable process embodied all these four elements used in the method of working the invention which the patentees necessarily showed in compliance with the statutory requirements that they "shall file in the Patent Office a written description of the same, and of the manner and process of * * * using it, in such * * * exact terms as to enable any person skilled in the art * * * to use the same," suggests that they regarded all four elements as constituting their workable process and, indeed, they attribute to heat the permeating and rapid coating of the minerals with oil.

Complying with the statutory requirement, the patentees say:

"The following is an example of the application of this invention to the concentration of a particular ore. An ore containing ferruginous blende, galena, and gangue consisting of quartz, rhodonite, and garnet is finely powdered and mixed with water containing a fraction of one per cent. or up to one per cent. of a mineral acid or acid salt, conveniently sulphuric acid or mine or other waters containing ferric sulphate. To this is added a very small proportion of oleic acid (say from 0.02 per cent. to 0.5 per cent on the weight of ore). The mixture is warmed, say, to 30° to 40° centigrade and is *briskly agitated* in a cone mixer or the like, *as in the processes previously cited,* for about *two and one-half to ten minutes,* until the oleic acid has been brought into *sufficient contact* with all the mineral particles in the pulp. When agitation is stopped, a large proportion of the mineral present rises to the surface in the form of a froth or scum which has derived its power of flotation *mainly from the inclusion of air-bubbles introduced into the mass by the agitation, such bubbles or air-films adhering only to the mineral particles which are coated with oleic acid.*"

It is urged that this is but a sample method of showing how their process was workable. But the sample element consisted in the particular treatment given to a particular character of ore. It was not a sample of one

of many possible kinds of agitation for the kind of agitation applicable to all kinds of ore was concededly of one sort, namely, as therein stated—"briskly agitated in a *cone-mixer* or the like, as in the processes previously cited." And the testimony of those who made the discovery and made the disclosure shows that the way and the only way they discovered and disclosed, was a definite kind of agitation and that this definite kind of agitation made their disclosed process workable. Indeed, that maximum of agitation and minimum of oil, increase of agitation and decrease of oil, were axioms in this process is made clear by the proofs. As the amount of oil was decreased, the amount of agitation had to be increased. In that regard, Sulman, one of the patentees, Vol. 1, p. 53, says:

"The first requisite of any oil concentration process is to obtain efficient contact between the oil and the mineral and suitable methods must be employed to effect this. Where the oil is in large relative quantity to the mineral *violent agitation is unnecessary* and may be very harmful. With decreasing proportions of oil more vigorous agitation or mixing *is necessary to ensure such efficient contact of oil with the mineral particles.* The agitation may, therefore, be said to be roughly proportioned to the work to be done in bringing about contact between large or small quantities of oil in regard to the mineral."

His evidence (p. 54) is that in the Gabbett mixer, of the cone type, he first saw produced the froth of the specification:

"The apparatus that I first saw the agitation froth produced in as described on the specification referred to was the ordinary Gabbett apparatus consisting of a vessel with rotating cone and with suitable baffles. The cone was rotated at a high rate of speed, about 1,000 revolutions per minute."

The use of the ordinary speed of the Gabbett mixer to effect the intermingling of the oil with the mineral particles, and the use of superadded speed for the purpose of entraining air and producing froth, is made clear by the testimony of Picard, another of the patentees. Thus (p. 109), in answer to the question:

"Q. In carrying out the process which the patent in suit purports to disclose, is there anything distinctive about the mode of agitation of the oiled pulp as compared with the agitation used in applying the Cattermole Process, wherein the purpose is to granulate and precipitate the valuable mineral?"

Picard says:

"In actual fact the same apparatus was employed for both purposes during my connection with the experimental work on the two processes. In the patent in suit it is *more essential to beat in air,* which is not an important point, and *rather to be avoided,* in the Cattermole process, where the object *was only* to mix the various ingredients, air not being one of them."

And he adds (p. 110):

"We already knew from the first test that the cause was due to reducing the quantity of oil much below that hitherto employed, and observation of the froth clearly indicated that the air which had been beaten in played an important and *essential* part in the production of this new phenomenon. I presume that further investigation work was carried on, but in my opinion, the invention may be said to have been completed after that first operation. * * * I had no idea prior to this, that by reducing the quantity of oil to the limits which were used in this experiment that such a result would be obtained I, of course, knew that air would float mineral, previously oiled, but it was not anticipated by me hitherto that this particular result would be obtained if *air were beaten in,* in the manner in which it was done in making this test."

John Ballot, the third patentee, also emphasizes (Vol. 1, p. 118) this "intentional beating in of air" caused by violent agitation, where in answer to the question:

"And when you saw the work in progress from March 1, 1905, onwards, as referred to by you in your answer to question 29, was this the first occasion upon which you had been informed as to the use in an oil flotation process of the *intentional beating in of air* for the purpose of promoting flotation,"

He says:

"*The intentional beating* in of air to produce or promote the flotation of froth which was developed by that process was certainly not known until the fact had been actually discovered by using a very small quantity of oil, say .2 or .1 per cent., and agitating it for a certain time, and then leaving the mixture to stand that the whole froth rose to the surface. By 'discovered' I mean until the experiments had established the fact that this extraordinary phenomenon was every time reproduced by using the small quantity of oil, *violently agitated,* and then leaving it to stand, when the mineral rose to the surface in the form of dense froth."

He adds:

"We considered it established and that the principal cause of flotation, or *perhaps the entire cause of flotation,* was *due to air beaten* into the pulp, assisted, of course, by the other agents."

Indeed, the discovery of beating air by agitation into the pulp as the ground-work of the discovery and therefore of the resultant disclosure, is summed up by the witness Ballantyne (Vol. 1, p. 225), in the words:

"After *violent agitation in such a way as to introduce air into the pulp, the agitation lasting several minutes,* the pulp was brought to rest immediately a coherent and persistent froth rose to the surface. Although I was closely familiar with all the earlier processes of ore concentration in which oil had been used, * * * the production of this agitation-froth was to me little short of a miracle."

In this development it will be seen that Mr. Ballantyne makes the violent agitation of the cone mixer the basic step in these words.

But not only was the testimony of these witnesses that this air-beating or air-entraining agitation was the agency which produced a froth of a hitherto unknown type, but we have the authoritative view of the Supreme

Court that the *lifting force* of the bubbles is to be found not in the quantity of oil used, but in the maximum of agitation, "greater than and different from that which had been resorted to before." We think the agency of this air-beating-in agitation as the functional cause of air flotation, is made clear by the Supreme Court. In that regard that Court says:

"The small amount of oil used makes it clear that the lifting force which separates the metallic particles of the pulp from the other substances of it is not to be found principally in the buoyancy of the oil used, as was the case in prior processes, but that this fact is to be found, chiefly, in the buoyancy of the air bubbles introduced into the mixture by an agitation *greater than* and *different* from that which had been resorted to before and that this *advance* in the prior art and the *resulting* froth concentrates so different from the product of other processes make of it a patentable discovery as new and original as it has proved useful and economical."

In quoting and approving the decision of the House of Lords, 27 R. S. C., the Supreme Court alluded to the dual functional capacity of the patentees' agitation: first, as a mixer of oil with the mineral particles (the function of Gabbett agitation at normal speed), and secondly, the formation of air cells by air entraining (the function of Gabbett agitation at abnormal speed). The extract thus quoted with approval from the English decision, is:

"They (the patentees of the *Agitation Froth Process* of the patent in suit) are not promoting a method of separation which had been before described, but they are engaged upon a new method of separation. Instead of relying upon the lesser specific gravity of oil in bulk they rely upon the production of a froth by means of an agitation which not only assists the process of *minute quantities* of oil reaching *minute* particles of metal, but *forms a multitude of air cells,* the buoyancy of which air cells forming around single particles of the metal, floats them to the surface of the liquid."

And that agitation of a particular kind, and not agitation of any kind, was the disclosure of the specification, is shown by Dr. Liebman, who says:

"I believe that 500 or 600 revolutions are quite sufficient for the Cattermole process (metal sinking). But I believe that at least 1200 revolutions per minute *are necessary* for the process of the patent in suit in the same apparatus."

From the above review, it is clear that the basis of this invention was agitation, and of agitation of a particular type and power, and that such type and kind of agitation gradually led to the further discovery that all oil except the minimum required for mineral coating could now be dispensed with. That the invention cannot be based on the use of a minimum of oil alone is clear, for the stress laid on agitation in the specification and its presence as an element in the claim here in issue, forbid any such holding, and the further fact that a claim based wholly on the use of a fraction of 1% of oil for coating minerals was abandoned during the prosecution of the patent, to wit: "The process of concentrating powdered ore which consists in separating the minerals from gangue by coating the minerals with oil in water containing a fraction of 1% of oil on the ore, and recovering the oil coated minerals."

Seeing then that no change occurs in the character of the oil itself, in the amount required to coat the metal particles or the affinity of the particles when coated, it follows that the essence of this patent lies in the agitation by which this low percentage of oil is made available. Now what was the nature of this agitation? It had a number of characteristics:

First—It was produced by machinery of high power operating on mechanism revolving at high speed. The mechanism was a special type, *i. e.,* a *top-inlet* or *cone* Gabbett mixer which embodied certain features, each of which was necessary to the successful working of the invention disclosed; a, the application of the mixer to the pulp was confined to such restricted zone of the *pulp* as was inside the cone; b, to this cone-restricted zone the air had access; c, the speed of the agitation was raised to a hitherto unused point; d, the air in the chamber was by the speed of the agitator beaten into the pulp segregated in the cone; e, in addition to high speed, time was required, the agitator being revolved from 2½ to 10 minutes before the entrance of air appeared in froth; f, the *agitation* was of such novel, individual and inventive character as to warrant the grant of a patent; g, the *agitation* was of such special type and speed that the froth it produced was also of a new type, or as the Supreme Court said, "utterly different from any froth known before."

But because the claims here in controversy use the word "agitation," without description or limitation, it is argued that the term should be used in a broad, generic sense and cover any and every agitation which results in the air flotation of mineral coated particles. Put into practical commercial application, this means a monopoly of the principle of air flotation of oil-coated minerals, with the one exception, namely, where 1% or more of oil is used. To our mind, this use of the literalism and verbiage of this one word agitation to foreclose this whole great controversy, loses sight not only of the spirit of the patent law, but also of the principles on which this contract—for a contract with the Government is what this claim is—should itself be interpreted, for in construing that contract we must construe it as a whole, that is, the claims plus the specification, and not the claims minus the specification. We must also consider the claims in the light of the evolution of experiment that led up to the discovery and consequently to the disclosure.

It is argued here that no sort of agitation is specified in the specification, that the phrase or idea of beating in air is not even mentioned in the specification; that there is no mention of any specific form of agitation, and that therefore there is no qualification or limitation to be given to the type or kind of agitation. But this loses sight of the fact that the patent is based on the Cattermole process, and that that process and the patentees'

used a Gabbett mixer, and when the word "agitation" was used in the specification it referred to what the patentees had used in making their discovery, and was well understood by persons versed in the art; and when they spoke of the production of froth by agitation they meant precisely what they reported in their experiments, to wit:

"The froth produced is not due to any action of the acid circuit upon traces of calcite present in the ore; *i. e.*, not to the liberation of any gas in the charge by means of the dilute acid employed in the circuit. It has been located, on the contrary, to the *air introduced by the Gabbett cone during agitation, the air attaching itself to the oiled mineral slimes and to a large proportion of the coarse mineral particles, although both these materials can only be coated with an infinitesimal amount of oil, i. e., oleic acid.* That the formation of froth is due to *air inclusions* during the agitation, and not to carbonic acid or sulphuretted hydrogen is proved by the following experiences:"

It is quite evident not only that this was the precise word and the disclosed sort of "agitation" they had in their minds when they disclosed their discovery. Moreover, we think that courts and Judges have held this was the meaning of "agitation." In passing upon the validity of the patent, the Supreme Court explained what the patentees' invention was, and defined the agitation of that discovery as "beating the air into the mass." This beating of air into the mass by the Gabbett mixer being the sense in which that word was used in the specification, and no disclosure or suggestion of any other agitation being made, the burden is certainly on the patentees to show that when the word "agitation" was used in the claim it meant anything else than the agitation disclosed in the specification, to wit, that of the Gabbett mixer or its substantial equivalent. For the word "until" in "agitating the mixture *until,*" aptly described the "two and a half to ten minutes" of the directions of the specification during which a Gabbett mixer was to be operated before the froth was produced. In so holding, we do not minimize, belittle or underrate the very important discovery these inventors made. But the great discovery they disclosed was based on two facts, oil of a certain amount and agitation of a certain kind. The quantity of oil was less than 1%. The agitation was by beating in the air until a froth came. That was the extent of their discovery, their disclosure and their claim. Within those limits they are entitled to protection. Beyond that the art has a right to progress and improve.

So regarding the claim, we turn to the defendants' plants, as to first of which, namely, the one in operation when the bill was filed, there can be no question. It is simply a replica of the plaintiff's process; used as a Gabbett mixer, as did Hyde in the case in the Supreme Court, and so far as it is concerned, infringement and an accounting should be decreed. But as to the defendants' second plant, I cannot agree that the claims in question cover it. I shall not enter into a detailed description of its working, but at present restrict myself to saying that the basic feature of the defendants' process is the sub-aeration of the pulp through the agency of compressed air. There is no air expansion as an agitation agency in plaintiff's process. They beat no air into the pulp; they introduce compressed air into the pulp and avail themselves of the instant expansion of that air to form a different kind of bubble from that of the patentees, and they get a different kind of froth. And the crux of the case may, as we view it, be stated in this way: If the defendants were applying for a patent for concentrating ore, which consisted in sub-aerating a mixture of ore and a fraction of one per cent of oil through the agency of compressed air, would such process be anticipated by the plaintiffs? The test of that question is not whether the product of two processes is the same, but whether the steps of the two processes are substantially the same. Addressing ourselves to that question, I have reached the conclusion that the defendants' process approaches the problem in a wholly different line from the patentees, and while the result is the same, that result is reached by steps or means acting in a different way and by a different method. Physically the defendants' method substantially and functionally consists in the liberation of air under light pressure, seven pounds compression, into the pulp mixture. Physically, by the turn of a stopcock this light pressure is turned on and instantly aeration and bubble forming begins and agitation follows. The physical difference between the two systems is as striking in its way as it would be if a person standing on the stern of an ocean steamer and seeing the maelstrom caused by the one hundred a minute revolutions of a screw, and should be told that these revolutions, the screws themselves, the shaft and the ship's great engines, could be taken out of the ship and their places supplied by a tank of air under mild compression. And yet that is just what these defendants have done. They have eliminated, not one hundred, but a thousand revolutions a minute of the Gabbett mixer; they have eliminated the shaft, couplings and power machinery which was necessary to actuate this. And for it they have substituted the stopcock of a tank filled with air under light compression. Defendants have eliminated such a distinctive element of plaintiff's process that it was patented. The physical difference between the means employed is well illustrated in this way: Suppose the owner of the Gabbett agitator were to sue the defendants for infringement by the use of a compressed air apparatus, could an expert be found so rash as to even suggest that the two were substantially equivalent? Not only are the two not mechanical equivalents, but it is evident that in the two processes the Gabbett mixer and the compression tank work on wholly different principles. The Gabbett mixer uses agitation to beat the air in, in order to thereafter produce bubbles—and that only after several minutes' work produces bubbles, and these bubbles only rise after the several minutes' agitation goes on. In other words, in plaintiff's process bubbles are the product of agitation. In the defendants' practice the

expansion of the air itself on its release from compression, at once creates bubbles and the instant rise of these bubbles to the surface at once sets up agitation. In other words, the defendants' bubble causes agitation, while in the patentees,' agitation causes bubbles. In the one there is a gentle agitation of the fluid caused wholly by the expansion of air when released from compression. In the other there is no expansion of the air, it is simply beaten into the mixture by the action of the arms of the Gabbett mixer. In the plaintiffs' process the agitation forms the air cells and only after several minutes' physical exertion; in the defendants' the air, on its release from compression, by its own inherent power, forms the cell and forms it instantly. It has been suggested that in defendants' process the air is shot into the mixture like a bullet from a gun and that there is no difference between shooting air into a mixture with a gun and beating it in with a paddle. But it is manifest that the defendants' practice is not the shooting in of a violent air-blast, but is in allowing air under slight compression to escape from such slight compression at the bottom of the tank. To have the compressed air strike the top surface of the pulp would not lead to any bubble introduction, and consequently to no subsequent agitation by arising bubbles, for such bubbles as would be formed would already be near the surface. It will thus be seen that the introduction of compressed air is necessarily made at the bottom of the pulp vessel, and it is also apparent that no such *sub-air* introduction which characterizes the defendant's process could be effected by the Gabbett beating in of the air, for in such case the moving blades of the mixer would have to be wholly immersed in water, and as we have seen heretofore, such immersion forbade the use of the top-outlet form of Gabbett agitation shown in Fig. 1. These differences in form and principle, the difference between a hurricane and a zephyr, the spread between the mælstrom action of a swift-moving mechanism and the bubbling, seeping action of air released from compression at the foot of a tank, and then in the case of the Callow cell oozing or seeping its way between the threads of a canvas, are so different in degree of violence and mode of action that one would naturally expect some difference should evidence itself in their product. And such is the case. In the defendants' process the bubbles rise at once to the surface, but they are so frail that they absolutely require the continuous support of other bubbles. For in case the air is shut off below and the upward bubble stream stops, those on the surface at once disintegrate. The defendants' bubbles are ephemeral; they are matured at birth; and, like all such creations, lack self-sustaining power. On the other hand, the plaintiffs' bubbles evidence themselves at the surface in a froth which is only formed after from 2500 to 11,000 revolutions of the mixer (2½ to 10 minutes x 1000 to 1100 revolutions), but when so gradually formed are so self-sustaining that they last for days and are so tough that they support a shovel. If the production of such froth by such a protracted and violent agitation was a contribution of inventive and novel worth to ore concentration, and apart from all authoritative decision that is our estimate of the goal it reached, then for another to reach that same goal without making the tough, persistent, shovel-carrying froth and without using the thousands of revolutions of powerful machinery, absolutely required to produce it, is also a contribution of inventive and equal worth to ore concentration. And the best evidence of its worth, of its simplicity and of its effectiveness is the fact that the plaintiffs themselves use it and concede its superiority. Concededly valuable as sub-aeration is, it is certain the ore concentration art never would have had it if we were dependent on the plaintiffs' patent to give it to the art. Not only did the patent in suit not disclose it, but if anything, their disclosure pointed away from rather than to the probability of the use of compressed air. Thus in their specification they take pains to avoid the imputation even of using gas as a flotation agency, and *ex majore cautella* give notice that "it is to be understood that the object of using acid in the pulp according to this invention is not to bring about the generation of gas for the purpose of flotation thereby," a statement the Supreme Court referred to as evidencing that their work tended not in the line of introduction of gas, but "to the presence of the air introduced into the mixture by the *agitation* which had been resorted to, to mix the oil with the particles of crushed ore."

Indeed, that the use of compressed air with their concentration process was not in the patentees' concept is strikingly shown by the fact that had they had any such use in view of the power of compressed air to do the work of the Gabbett mixer, their suggestion of the possibility of its use was almost challenged by the use to which they suggested it could be put to in the second and third spitzkasten where no mixing or separation was required. They there say:

"An alternative method for the recovery of any sunk oiled metalliferous matter which may be deposited in the second and third spitzkasten is as follows: The products suspended in circuit liquor are removed from the spitzkasten and placed in a vessel in which they are submitted to an *additional pressure of air or other gas* of from, say, one to two atmospheres or over. On relief of such pressure the bubbles of air or other gas *so generated* throughout the mass at once sweep to the surface thereof all the metalliferous matter in the form of a froth which can be separated as before. This idea is not claimed broadly in this case, but forms the subject-matter of an application filed by us on January 9, 1906, Serial No. 295,326."

Of course, whatever ideas they had on the subject were embodied in another application and offered no basis for a claim in this patent, but even this suggested use of compressed air as a flotation agent to these experienced men suggested to them no use of that agency in the process of this patent. It remained for some other engineer, in this case the defendants' experimenter, to discover and disclose it. This view is emphasized by the fact that five years after this patent was applied for and two years after it became the owner of it by assignment, the plain-

tiff joined with one Hoover in applying for a British patent for such use of compressed air. In that patent the patentees themselves emphasize the points we have made, saying:

"This method of introducing the gas may have three functions: (1) The *gas* may *bring about* the necessary agitation of the mass. (2) The gas being in a state of very fine division, is effecetively brought into contact with every mineral particle, thus *clearly differentiating the process* from that of the patent where the mechanical stirrers caused the agitation and thus *preceded bubbles,* while here *bubbles preceded and caused agitation.* In the patent in suit the mechanical action of the stirrers, kept up for ten minutes, brought about air being brought into contact with the mineral particles, while by the sub-gaseous process, the gas being in a state of fine division through seeping through the canvas, is as said above, 'brought into contact with every mineral particle.'"

The fact that the present plaintiffs, five years after the grant of the patent, joined Hoover in taking out this patent, in itself shows that it then regarded the sub-air process as one not covered by the patent in suit, and may well cause a court to hesitate to give a construction to the patent in suit which is at variance with the plaintiffs' conduct in taking out this Hoover patent.

To me it seems clear that the field of discovery the patentees disclosed was not the broad principle of air flotation, for concededly that principle was known before. What they did disclose was an original method of using the broad principle of air flotation in a particular way. That method was by beating air into pulp with a minimum of oil. They showed how the beating in of air could be effected, and they showed a novel froth product as a result of this beating-in process. In their process air was the product of agitation and not the agitating agent. In their process bubbles did not appear until protracted agitation was ended. Not only was it produced by agitation, but it did not appear until agitation ceased. It will thus be seen that air was in no way an agitation agency in the plaintiffs' process, in its specification or in its claims, but the agitation disclosed therein was wholly the physical agitation of an extraneous mechanical process. Now, this occupancy of the field of air flotation, novel, useful and inventive, the plaintiff disclosed and should be awarded. But by occupying this part of the field, the process of entraining air by mechanical beating in, the plaintiff did not foreclose all further advance in air flotation. Air flotation, as a recognized principle, was known before this patent, and by discovering one way to utilize that principle, the patentees did not bar all other ways of making use of that principle. If they had discovered the broad principle of the capacity of oil to coat minerals and to reject gangue; if they had first discovered the coating of air bubbles with oil; if they had first shown that oil-coated minerals and oil-coated bubbles would unite and rise to the surface, we could regard them as first-comers into a newly discovered field, and as entitled to make all further progress in that art servient to those who created it. And while this has been done in some notable instances, it is nevertheless true that even great and notable steps in a great art can be disclosed by patentees without blocking all further progress in that field. In that regard we are admonished by the later rulings of the Supreme Court in patent causes, which began with *Westinghouse* v. *Boyden,* that even such a great invention as the instantaneous stoppage of every car on a great freight train, an invention which is at the bottom of the movage of tonnage today, did not bar other inventors from showing other means of using air to accomplish the same result. And such holdings as *Westinghouse* v. *Boyden* and the like, seem to us the true principle which should govern the administration of the patent law, namely, giving full protection to the full limit of the disclosure made, and refusing to extend that limit so as to bar further advance by others. Applying that principle to the present case, I would hold that the step of the process "agitating the mixture until the oil-coated mineral matter forms into a froth," meant the novel air entraining agitation which the patentees disclosed and did not cover the novel air releasing agitation which the defendants disclosed. In accordance with these views and in support thereof I am constrained to record my respectful dissent to the opinion of the Court.

PRELIMINARY ESTIMATES based on practically complete returns made to the U. S. Geological Survey, by domestic refiners of platinum, indicate that in 1916 approximately 488 oz. of domestic crude platinum (about 74% metal) was refined, producing 172 oz. platinum, 84 oz. iridium, and 113 oz. iridosmine, and that 10,118 oz. of South American crude platinum, about 88% pure, was refined. The platinum metals produced by refining crude placer-platinum, of both foreign and domestic origin, amounted to 8943 oz. platinum, 235 oz. iridium, 199 oz. iridosmine, and 18 oz. palladium. Refiners of copper matte and gold bullion report a production from foreign and domestic material of 2556 oz. platinum, 100 oz. iridium, and 2746 oz. palladium. About half of this was produced from domestic materials. The total production of new platinum metals in 1916 was about 11,500 oz. platinum, 335 oz. iridium, 200 oz. iridosmine, and 2765 oz. palladium. The scrap platinum metals sold in the United States in 1916 amounted to approximately 49,400 oz. platinum, 980 oz. iridium, and 2000 oz. palladium.

ALUMINUM alloyed with 10% calcium makes a metal of superior qualities, lighter than aluminum, and particularly desirable for castings to be used in automobiles and aeroplanes. These castings machine well, are free from brittleness, and take the minutest impressions of the mold. Alloys of copper, tin, or zinc, with aluminum are softer and heavier than the calcium-aluminum alloy, and are less resistant to corrosion. The calcium also neutralizes the tendency of the aluminum to oxidize. It does not decompose in water, and can be remelted as readily as pure aluminum. This alloy is the discovery of Hugh S. Cooper of Cleveland, Ohio.

Conditions in Mexico

By AN OCCASIONAL CORRESPONDENT

According to the Government press, Mexico re-entered the 'constitutional' era on May 1, the "un-constitutional" era having lasted since Huerta's usurpation in February 1913. The inauguration of Venustiano Carranza was marked by an extra national holiday, and this coming on Tuesday of the same week as the regular holiday of Saturday, meant a week of loafing for a large part of the peon class. Among the many festivities of the week in Mexico City was a sham-battle by a brigade of school-boys with real guns. Unfortunately, the first volley resulted in the wounding of a great many boys by the bullets of the 'blank' cartridges. Some say that the accident was due to some disgruntled general, who had the ball-cartridges mixed in for the purpose of discrediting Carranza, but American miners will be more apt to believe the theory that it was merely a typical example of Mexican carelessness, exhibited in the munition department of the army. The national Congress assembled on April 15 in Mexico City for the first time since Huerta's *coup d'état* in October 1913. A fortnight previous the national capital had been transferred back to Mexico City, from Querétaro, where it has been since Carranza's departure from Vera Cruz in September 1915. Like the 'constitutional assembly,' which closed its work in Querétaro on February 28, the new congress is a carefully hand-picked body of Carrancista partisans. In many districts there were several independent candidates; but no matter how many votes he got, a non-official candidate (where not counted out in the local returns) was easily disposed of by the credential committee at Mexico City. The large vote cast, so widely heralded in the foreign press as a sign of popular enthusiasm, was really caused by a decree which penalized the failure to vote by the loss for a year of citizenship-rights. As Carranza was the only presidential candidate, he could not fail of election, no matter who voted, and he was, of course, 'unanimously' elected. A curious feature of the election in Mexico City was the candidacy of Dr. Atl, whose campaign had to be conducted by his friends, as the Doctor was in hiding, due to his proscription last September. If elected, he proposed to appear and claim the legal immunity from arrest of a deputy, but luckily for the repute of the brand new constitutional machinery, it was not subjected to any such excessive strain, for Dr. Atl was ruled out in committee.

In Anglo-Saxon countries, the main object of parliamentary institutions is to control the public purse, but this does not hold in Mexico, since one of the first acts of the new congress was to grant 'extraordinary faculties' to the Secretaría de Hacienda, that is, the Treasury Department. This means that secretary Louis Cabrera can continue his irresponsible career and issue decrees concerning national finance, taxation, and expenditure, to suit himself and Carranza, without any reference to the congress. The looting of the banks of issue beginning last December, seems to be nearly completed, as most of their vaults have now been emptied of their metallic reserves, and part of the process of liquidation it at present being conducted by the various Incantación commissions appointed by Cabrera. It seems probable that a large part of the ₱40,000,000 worth of gold bullion now being coined for Mexico as an 'international courtesy' at the Philadelphia mint, hails from these bank reserves, since it consisted largely in gold and silver bars. That this bullion proceeds from the Mexican bullion tax, as stated to the press by Cabrera, is physically impossible; because, though the normal Mexican output of gold is about ₱40,000,000, it has scarcely been a third of this for the past three years, while the bullion tax has only been 10% on the gross output.

Since December last the soldiers have been paid in coin at about the same rates that were prevalent under Madero, but the civil service has had to accept 50% of its wages in bonds, so that instead of real money it has received certificates of indebtedness; but from July 1, civilians will also be paid entirely in coin at the rates of 1912. When the Government was on a paper basis, from 1914 to 1917, it accepted American money for taxes at the rate of $1 for ₱2 of Mexican gold, but since specie payments have been resumed it has found it profitable, especially in its collection of taxes from American miners, to artificially depreciate it.

The Southern Pacific Co. played an important part in assisting the Pacific Coast to over-subscribe the Liberty Loan. Figures made public at the general offices of the company in San Francisco, show that the total amount subscribed by employees on the Pacific system alone reached $1,319,000, which sum was pledged in 12 days after the call issued by President Sproule. Among the large individual Southern Pacific subscriptions were those of Mr. and Mrs. William Sproule, $25,000; chief counsel Wm. F. Herrin, $24,000; vice-president E. O. McCormick and family, $10,600; chief engineer Wm. Hood, $5000; claims attorney D. R. Sessions, $5000; assistant chief engineer J. Q. Barlow, $2000; vice-president and general manager W. R. Scott, $2000; auditor T. O. Edwards, $1100; A. D'Heur, manager of fuel-department, $1000; Dr. F. K. Ainsworth, chief surgeon, $1000; R. J. Clancy, assistant to the general manager, $1000; superintendent of transportation G. F. Richardson, $1000; H. P. Thrall, inspector of transportation service, $1000; D. P. Kellogg, superintendent of motive-power at Sacramento, $1000.

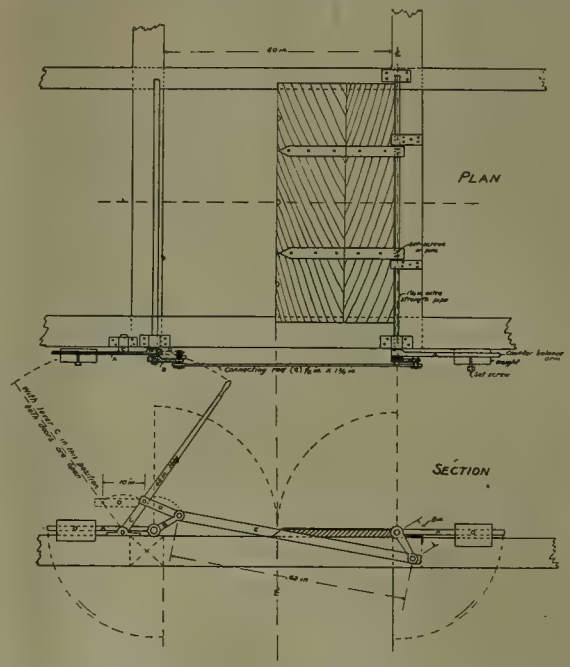
Coal-tar creosote is largely used for mine-timbers, railway ties, and for timbers in situations exposed to conditions favorable to the growth of destroying fungi and bacteria. The toxicity of creosote to such growths is well known, but it has been demonstrated by C. J. Humphrey that maplewood creosote is from 2 to 4 times as effective. It kills the fungus-growths when used in dilutions as low as 0.1% of the creosote in an alkali emulsion. In this respect it is equal to beechwood creosote.

Automatic Skips in Shaft With Rope-Guides

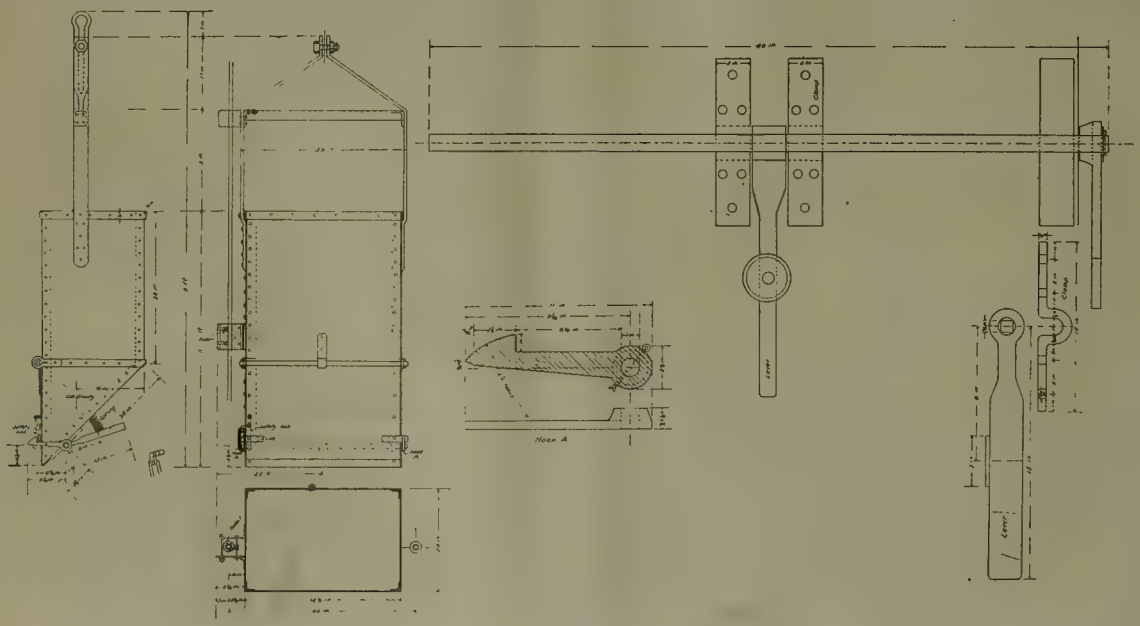
By H. VINCENT WALLACE

The accompanying detail drawings show an automatic skip used successfully in the 2000-ft. shaft at Nueva Luz, Guanajuato, Mexico, standing the test of over 250,000 trips without failure to properly operate. This entire equipment was constructed in the blacksmith shop at the mine by an ordinary Mexican blacksmith and helper. It will be noted that the hook-levers that engage the skip-doors are keyed to the shaft, which is also keyed and set-screwed to the operating lever placed under the sloping bottom of the skip; the safety-link, therefore, when hanging over one hook, securely holds the other against its lug, in addition to the spring which keeps the centre lever at all times tense.

To empty the skip it was the duty of the top-man, first to drop the apron having high sides, this being attached to a counterpoise and provided with a short cable and pulley. Next the safety link is thrown back. The hoisting engineer then lowers the skip until the lever, by pressing on the apron, releases the hooks, allowing the load to be discharged into the bin. When the engineer raises the skip to disengage it from the apron the skip-door swings shut and is automatically locked by reason of the spring exerting the necessary pressure on the lever. If by any chance the top-man fails to drop the safety-link, the skip-tender is warned to check him before filling the skip at the shaft-pocket below, and the mine-record shows that the device was efficient even in the hands of the Mexican workmen. The photographs accompanying this article show the skip in various posi-

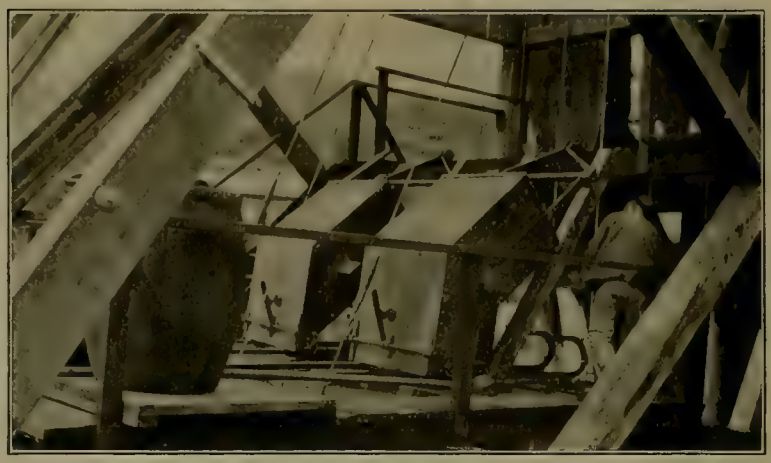


DETAIL OF BALANCED DOORS

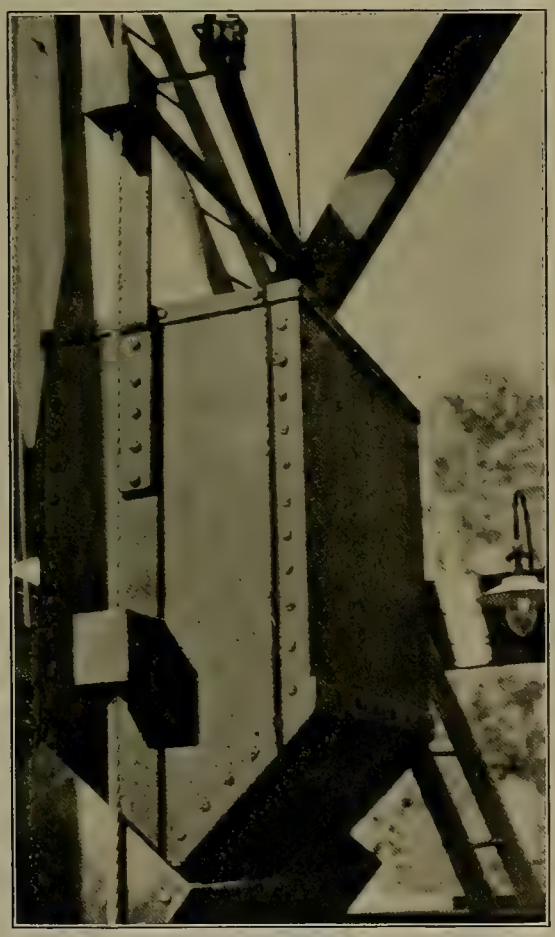


DETAIL OF SKIPS, SWINGING APRON, AND LATCH

tions. The balanced shaft doors are not claimed as an original idea, but were developed and the design prepared in detail from recollection of a pair seen in operation somewhere in Staffordshire or South Wales about 1889. Previous to this installation, it had been the custom to have two top-men, one on either side of the shaft, each operating one door. These, when closed, were in the form of an inverted V. One man then had to hook the bucket and direct its 'dump' as the engineer lowered it. On the bucket being discharged the two men again, with an expenditure of a good deal of power, opened the doors and allowed the bucket to be lowered into the shaft. In the event of lowering tools or other materials, one or the other of these men had to descend to the collar of the shaft. All this led to delay and caused extra expense. Moreover there were inverted V doors both at the collar of the shaft and at the dumping level above.



SWINGING APRONS ERECT, AND IDLE SKIPS ON PLATFORM



SWINGING APRON AT MOMENT OF DUMPING

The balanced doors shown in the accompanying illustrations could be operated either by the top-man or by the hoist-engineer, although the drawing does not show the rods connecting with the hoist-house. These doors can be made readily in any ordinary mine-shop, the only parts required from a foundry being the properly calculated cast-iron counter-balance weights. It should be noted that the strap-hinges, counter-balance arms, and the 8-in. radius-levers, are all intended to be keyed and fixed in place with set-screws, the counterweights to be adjustable for the weight of the door and fixed at the correct distance with set-screws. It was found that one top-man could easily attend to both pairs of doors in the double-compartment shaft, as it required about 7 min. per trip. When the skips were hoisting waste or ore, the same top-man attended to the unloading apron and the safety-link, since it was found quite unnecessary to close the doors after making about 1000 trips, as not a particle of rock ever found its way down the shaft when a skip was being discharged.

STRONTIUM is in limited demand at the present time for the manufacture of red-fire to be employed in signalling. The mineral celestite ($SrSO_4$) is preferred to strontianite ($SrCO_3$), and is worth about $12 to $14 per ton at Atlantic ports. Celestite exists in large deposits about 5 miles north-west of Austin, Texas, at Mt. Bonnell, the grade obtainable assaying 97 to 98% $Sr\ SO_4$. It is found in many places rather abundantly in the Silurian limestones and dolomites. In series of lime deposits from the concentrated brines of inland seas, chemically precipitated lime ($CaCO_3$) will go down in advance of the strontium minerals, but the latter will precipitate ahead of the gypsum. Therefore strontium deposits are not infrequently found beneath beds of gypsum. Celestite is often disseminated in small aggregations along with limestone or with gypsum, but, owing to its relatively high specific gravity (3.95), it is amenable to concentration. A large deposit of celestite was recently discovered four miles north-east of Lavic station on the Santa Fe railroad, San Bernardino county, California.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

CRIPPLE CREEK, COLORADO

OVER A MILLION PAID IN DIVIDENDS THIS YEAR.—IMPORTANT NEW LEASES OPERATING WITH SUCCESS.

Sunday, June 10, was dividend day for stockholders of the Cresson Consolidated Gold Mining and Milling Company, and Golden Cycle Mining and Reduction Company. The Cresson dividend was at the rate of 10c. a share, amounting to $122,000. The Golden Cycle dividend was at 3c. a share, making $45,000, a total for the month of $167,000.

With these distributions Cripple Creek corporations have paid stockholders in the first six months of 1917 $1,312,941.42. The dividends of the so-called close corporations are not included in the foregoing sum.

The companies and dividends to date for 1917 follow: Cresson Consolidated G. M. & M. Co. (monthly), $732,000; Golden Cycle M. & R. Co. (monthly, $270,000; Portland Gold Mining Company (quarterly 3c.), $180,000; Vindicator Consolidated Gold Mining Company (3c quarterly), $90,000; Doctor Jack Pot Mining Company (1c.), $28,441.42; Jack Pot Mining Company of Wyoming (1c.), $12,500 Total, $1,312,941.42.

The May production from the Acacia Gold Mining Company's South Burns mine, on Bull Hill, totaled about 250 tons, seven broad-guage cars, with an average value of $26 per ton. Shaft-sinking was in progress and production was necessarily curtailed. Between 7 and 10 cars of ore have been shipped from the mine since June 1.

Shipments were started on June 11 from the new three-compartment (Scott) shaft, on the Happy Year group of the War Egale Consolidated Mines Company, on the southwest slope of Bull Hill. The ore is of milling grade and is mined from a shoot 110 ft. long, recently opened by a lateral from the 400-ft. level. Lessees are operating on two blocks of the War Eagle adjoining the Happy Year group, and are saving ore of milling grade.

Twenty-eight cans of concentrates, 18 cans from the Independence mill, below the ore-house at Stratton's Independence, and 10 cans from the Victor mill, on Battle mountain, were forwarded on June 11, by express from Victor to the Valley mill of the company, at Bruns, near Colorado Springs. This is a record shipment for any one day from the two plants. The ore concentrated had a gold value of $2 per ton. During May, the concentrate cans had an estimated value of from $800 to $1000 each.

Shipments have been commenced from the Forest Queen, an Ironclad Hill property, under lease to Edwin Gaylord, formerly of Denver. A cave in the old workings, which occurred before Gaylond took possession, carried down and filled the stope between 600 and 450 ft. with ore worth from $8 to $12 per ton. Gaylord has equipped the shaft with a steam-hoist and 60 hp. high-pressure boiler and is hoisting this mill-ore with a skip, while development in the mine proceeds.

Illinois and Michigan capital, represented locally by Sam Cleverdon, is interested in a lease on the Nightingale, a Stratton Estate property on Bull and Raven Hills. Cleverdon is sinking a new shaft on the Raven Hill side of the claim, near to the Maggie claim of the Cresson Consolidated Company. Machinery will shortly be required.

Al Osberg, lessee of the Mable M., of the Gold Dollar Consolidated Gold Mining Company, closed a five-car shipment from the new ore-shoot recently opened up at the 500-ft. level of the Mable M. shaft June 9. Osberg estimates this trial shipment at 2 oz. of gold per ton.

Company work at the 18th and 19th levels of the Golden Cycle shaft of the Vindicator Consolidated Gold Mining Company is producing a fair tonnage of a medium-grade ore, and making a large production in the deep levels of the Vindicator main shaft. The Hull City mine, after long idleness, is active under lease to Frank Seeley, a former district operator, now of Oklahoma. The mine is producing a milling-grade of ore.

The May production from the active properties of the United Gold Mines Company, the Trail, Bull Hill, W. P. H., and Damon mines, on Ironclad Hill, and the Silver Tip mine, Bull Hill, totaled 2500 tons of a gross bullion value of $50,000. The Trail mine, with 3 sets of lessees, alone produced 57 broad-guage cars and the W. P. H. mine 16 cars of ore.

A carload of ore from the Mountain Beauty mine, on Bull Hill, owned by the Mountain Beauty Gold Mining Company, and operated by lessees, Schoolcraft, Bulter & Co., brought settlement last week at the rate of 5.81 oz. gold, or $116.20 per ton. A carload of second-grade ore was settled for at $40 per ton.

The Granite Company, operating the Dillon mine on Battle Mountain, continues to load out from three to four cars of ore daily by team, but the overhead-tram is nearing completion and the cost of transportation will soon be reduced. Lessees on the Dead Pine, Monument, and Gold Coin properties of the company also are shipping steadily, the ore being consigned to the mill of the Golden Cycle Mining and Reduction Company, at Colorado Springs. Colorado City, as a corporation, passed out of existence the night of June 10.

The Strong shaft is being sunk to the 1550-ft. point. The mine continues to produce a high-grade ore. The Strong Company, a close corporation, is sinking the shaft, and a depth of 1550 ft. will shortly be attained.

Upraising from the 13th and 11th levels of the old Modoc incline, directly under the new vertical Frankenberg shaft, on the property, was started on June 11. The vertical shaft is now completed and timbered with square-sets of Oregon pine, to the 700-ft. point, and lateral work will be started on an elaborate scale when the raises are through. Lessees in the old incline are producing a fair tonnage of milling-grade ore.

Matt Edwards and E. G. Fink, of Victor, representing Eastern men, have secured a lease on the Ramona, on Bull Hill, and are figuring on a mill and mining machinery.

JOHANNESBURG, TRANSVAAL

DIAMOND-DRILLING ON THE FAR EAST RAND CONSIDERED UNRELIABLE.—SUGGESTIONS FOR BETTER METHODS.—A GREAT CENTRAL MILLING-PLANT SUGGESTED.

The news of the intersection of the reef by the bore-hole on the Spaarwater Farm, near the Nigel, on the Far East Rand, was received with much interest, and the assay results of the core were anticipated with some anxiety, by those interested in the property. The cores were described as apparently well mineralized but the assays have not confirmed the favorable first impressions. The top 4½ in. of the reef gave only traces of gold, the next 5 in. 2.4 dwt, the next 2½ in. 1.7 dwt, and the 4½ in. next the foot-wall only 2 dwt of gold to the ton of 2000 lb. Now, that the results have turned out so disappointing, the tendency is to place reliance only on the proved depth and

width of the reef, and none whatever on the assay values. Naturally bore-holes are only a limited guide to the true value of a lode, a fact which is generally recognized on the Rand. The Victoria bore-hole, near Germiston, put down to test the deep levels 25 years ago, yielding cores giving abnormally rich results, but subsequent mining operations have proved the neighboring ground to be the most poverty-stricken on the Rand. Nor were the excellent results of the Geduld bore-hole ever realized, while at Brakpan and Modder "B" the mining results have far outstripped those indicated by the bore-holes. Many similar instances might be quoted, but nevertheless, when the Spaarwater results are taken in conjunction with those obtained on the farm Vlakfontein belonging to the Lace Proprietary Mines, there is a tendency against regarding this portion of the Far East Rand as over-promising. The Spaarwater bore-hole may, after all, have struck a small patch of poor ground, or on the other hand, it may be a south-easterly continuation of the large low-grade area proved to exist near Boksburg, on which the Boksburg, East Rand Extension, Van Dyk, and Rand Collieries occur, and which to some extent would conform to the views expressed by Dr. Mellor on the Reef as characteristic of the Far East Rand. After all, the Spaarwater bore-hole has cast little further light on the mining value of this doubtful portion of the Far East Rand, and until shafts are sunk and the value of the reef proved by actual exposure, nothing reliable will be established.

Rand mining men have been somewhat severely lectured by George Denny, who says that during the last decade, he can see no pronounced changes or improvements in their methods, the tendency of Rand mining-methods being, he considers, to much along the lines of least resistance. These views, among others, were enunciated in a paper read by Mr. Denny before the South African Institute of Engineers with the object of providing matter for discussion at the subsequent meetings of the Institute. Mr. Denny pointed out that during the last dozen years while working-costs have apparently fallen 8s.4d. per ton, the yield during the same period has fallen 15s.9d. per ton, and he pertinently enquires, "how much of this reduced cost per ton is due to actually increased economy in working, and to what extent is it due to the milling of cheaply-mined ore, which may be returning less gold than it actually costs to mine and treat? Also to what extent if any is the marked reduction in yield per ton of ore milled due to the same cause? The reduced working-cost of ore milled on the Rand has been brought about by a variety of causes, principally cheaper fuel, railway rates, stores, explosives, adoption of electrical-power, more economical methods of development, and no doubt to a considerable extent, to the working of cheaply-mined ore, but not necessarily of unprofitable value. That the fall in the average grade of the ore milled to-day on the Rand, is not altogether or largely due to the milling of unprofitable ore, as suggested by Mr. Denny, is shown by the fact, that with scarcely a single exception, the value of the reef has declined with depth from one end of the Rand to the other. That the decline in value may be due to increased depth cannot be proved, but it is a coincidence not otherwise easy of explanation. Mr. Denny can no doubt remember a time when all ore below a value of 10 dwt. per ton was regarded as unprofitable, but to-day profits are claimed to be made on ore assaying less than one-half of that value. No doubt a large part of the profit earned today, is derived from ore, which during Mr. Denny's sojourn on the Rand, was considered too low in value to be mined and treated at a profit, but that to-day is capable of cheaper exploitation, and the whole aspect has changed.

Mr. Denny had much to say against each mine having its own milling equipment, on the score that it added to the capital expenditure unnecessarily. He even suggested one huge mill for 25 big mines on the Far East Rand. This is a new suggestion for the Rand, and in some cases might be followed with advantage, but big mills and concentration of milling operations have not achieved the success anticipated on the Rand. An explanation of the uniform methods of treatment adopted on the Rand, even to becoming depressing, may be found in the uniform character of the ore, but it is scarcely correct to say that during the last decade no improved methods of treatment have been adopted here. Several instances may be quoted, however, where any radical departure from established methods have been attended with conspicuous failure.

There are, however, several statements in Mr. Denny's paper that are beyond dispute, and some of these suggestions are worthy of serious consideration. Many of these are not new, especially with regard to the want of a more rational method of expressing the value of ore-reserves, and what really constitutes profits and profitable ore, which, if I mistake not, were originally suggested by T. A. Rickard. The suggestion that other units rather than tons, should be adopted as a cost divisor, has also been made by H. Marriott. Undoubtedly the method of cost-keeping can be improved on the Rand, and in such a way as to assist the mine manager in keeping a more intelligent check on the profits, but it would scarcely result in bringing about such a revolution in Rand mining methods, as George Denny seems to consider imperative and necessary.

KOOTENAY, BRITISH COLUMBIA

NUMEROUS PROMISING MINES THAT REQUIRE ONLY CAPITAL AND COMPETENT MANAGEMENT.—FAVORABLE WORKING CONDITIONS AND SHIPPING ORE.

The Steele group, in the North-East Kootenay district, adjoins the Lead Queen mine, and is a continuation of the Lead Queen vein. A 60-ft. cross-cut adit reaches the vein, but no drifts have been run, though the vein has been exposed on the surface for 300-ft., where it is 18 to 24 in. wide and assays from 35 to 50 oz. silver, and 50 to 60% lead per ton. The mine will be developed this summer and ore-shipments made.

The Delos group is on Boulder creek about three miles from the Horse-thief creek wagon-road. It is a Crown grant property and has been idle since 1898. It is reached by a good trail, which could easily be widened to a wagon-road. The ore is chalcopyrite, with some gold and silver. This mine is situated on a zone of quartz stringers that intersect the slate in all directions—a stockwork 150 ft. wide. The quartz stringers are from one inch to two feet wide. An adit has been driven 53 ft. near the creek-level. It makes a good showing of copper ore. On the surface masses of copper sulphide are found in the quartz. It is the intention to mine and ship ore this summer. Clear ore runs 32% copper. There is considerable ore on the dumps ready for shipment.

The Bunyan group comprises four claims at the foot of Bunyan mountain, between Toby and Goldie creeks, and six miles from Invermere. The vein is 16 ft. wide, in which a pay-streak 3½ ft. wide runs 15 to 20% copper and 16 oz. silver. There is an adit in 60 ft., with some drifts and a winze 20 ft. deep at one place, and numerous surface cuts, short adits and other superficial work. There is abundance of timber, and a good water-power is available. This property has been idle for several years. The Golden division is bounded on the south by the Windemere division, on the west by Ainsworth, Lardeau, and Revelstoke divisions; on the north by the Quesnel division, and on the east by the Alberta-British Columbia boundary.

The Monarch mine is 1000 ft. above the track of the Canadian Pacific railroad, three miles east of Field. The mine was discovered in 1885 and has since changed ownership many times. The camp-buildings and mill are at the railway, and are connected with the mine by aerial-tramway. The orebody is a replacement in limestone, and is from 15 to 30 ft. thick, with great longitudinal extent. The ore is sulphide, principally zinc. The mill is provided with the usual concentrating machinery, and has a capacity of 70 tons daily, turning out a

75 to 85% concentrate in which zinc runs 45 to 50% and the lead 55 to 65%. The mine has a good equipment of machinery, including a gas-engine situated at the top of the tramway and used to hoist supplies from the railroad to the mine. An adit has been driven 400 ft. on the orebody, and considerable stoping done on both sides. The mine is idle, though there seems to be no reasin why it should not be in profitable operation with metals at their present high price. The property is owned by the Golden Giant Mines, Limited, of Victoria. The Giant mine is on the north side of the Spillimachene river, seven miles west of Spillimachene station. The ore occurs along the contact of limestone and slate, with an east-west strike and south dip of 60 to 80°. Barite is abundant in a zone 20 to 30 ft. wide, the limestone being silicified at a greater distance from the slate. In places the barite is impregnated with galena, from 5 to 10%, with a lower content of zinc, arsenic, and antimony sulphides. The galena is fine-grained and often is found in small seams. It carries silver to the extent of one ounce to each per cent of lead. An open-cut 60 ft. long, 50 ft. wide, and 30 ft. high at the face represents the main surface development. An adit has been run 325 ft., and 50 ft. below the open-cut another adit is in 265 ft., in which ore was first cut 60 ft. from the entrance. From the ore-bins just below the cut a gravity tramway has been built to the concentrating-mill. The ore goes to a Blake crusher, from which it passes to a Robins picking-belt conveyor. The ore drops onto a grizzly, the fine going to a fine-ore bin, the coarse being re-crushed and then joining the fine in the bin, from which it is fed automatically to rolls. The plant proved unadapted to the ore, and as a consequence the property has been idle for several years. In 1916 three cars of ore were shipped to the Trail smelter, and ran 26% lead and 5 oz. silver per ton. With proper machinery in the mill and competent management this property should be worked continuously and profitably. There are large outcrops of ore on the mine where practically no work has been done. Free water-power is avail able, and transportation facilities are good.

The Copper Butte mine is on a small branch of Bugaboo creek, five miles from Bugaboo creek wagon-road. This property was worked during 1916, though not steadily. Two cars of ore were shipped to Trail, which ran well in copper, which occurs as chalcopyrite. Not having sufficient working-capital to operate the mine in an economical manner, the owner was forced to suspend operations. The Tennessee group is on Spruce Tree creek. The vein is from 3 to 10 ft. wide, with a streak 6 to 8 in. wide of solid chalcopyrite, carrying $3 to $4 in gold and about the same value in silver per ton. The selected ore runs 23 to 33% copper, the entire vein averaging 13% copper. Work will be commenced early this summer, and the ore shipped to Trail.

Generally speaking, comparatively little work was done in the Golden mining division in 1916, but the increase in the price of metals has stimulated the owners of many mines to undertake active work during this season, and to ship their ore. What the district needs is more capital and experienced management.

There is a copper belt in the Selkirk range running northwesterly from Ditch creek to Fifteen-Mile creek. Orebodies are exposed in nearly every creek cutting through this belt, which is over 70 miles long.

Within a mile and a half of Canal Flat railroad station there are two parallel lodes on the north side of Findlay creek, locally called the East and the West lodes, respectively. These lodes are over 100 ft. wide in some places. The ridges rise from 300 to 500 ft. above the neighboring canyons; and mining facilities are unusually good. Timber and water-power are both abundant. The ores carry from $1 to $5 in gold, and from 1 to 40 oz. silver, and about 50% lead per ton. For large capital these lodes offer many promising opportunities, as mining and metallurgical operations can be carried on at low cost, and transportation facilities are better than in many other districts where mining is successfully carried on.

Throughout the North-East Kootenay, including the Windemere and the Golden Divisions, there are many promising properties that require capital, and men who have had sufficient practical experience with mines of the type that are plentiful in this region. What is wanted here is men of the kind that developed the Slocan district, and who were not afraid to stay with the game through many disappointments and trials until they had made a success.

WILLOW CREEK, ALASKA

A Quartz Mining District that is Making Good.—Pioneer Mill Methods Give Profitable Results.—A Power Company Organizing.—Dredging a Success.—A New Placer District Reported.

The Willow Creek District is approximately 75 miles from Anchorage, the headquarters of the Alaska Railroad Commission. Supplies reach this region either by way of the Susitna river or by way of the railroad to Wassili. The ore of this district is a free-milling, highly silicious ore, the high-grade ore usually occurring in shoots in the main ore-body. Coal may be obtained from the deposits of Matanuska, and a railroad-spur is run to within fifteen miles of the camps. Timber is scarce in the district, and is all brought in from other points near by. Good trails are being put in and there is automobile-service in the summer months.

No great depth has as yet been obtained on any of the orebodies, but in the history of this camp no vein has been known to have become impoverished or to have cut-out as depth was obtained. The mineralized region is approximately six miles square, containing innumerable veins. The ore has averaged for the year 1916 in the neighborhood of $45 per ton, in many cases shipping-ore, running into the hundreds, is mined. A description of some of the larger plants will show how this camp is coming to the front while using milling-systems that to the modern mill-man seem like the arrastra, in comparison to up-to-date plants, yet making high recoveries.

The property of the Alaska Free Gold Mining Company, under lease to William Martin, of Seattle, is situated on Fishook creek, one of the small tributaries of Willow creek. The ore occurs in several bodies, which are mined by a series of connected workings, no special line of mining being adopted owing to the nature of the veins, which are very irregular. Narrow stopes and workings of the Cripple-Creek type are most common in this high-grade district. The formation is diorite, striking N. 23° W. and dipping 30 to 35° south-west. Three aerial-trams connect the mine to the mill-bins, the mine workings being 1000 ft. above the mill. A 750-ft. tram on the east side of the mountain connects the mine-bins, of 100 ton capacity, with an intermediate station from which the ore is trammed by cars to a second bin 500 ft. away. From this second bin the ore is sent to the mill by means of a single-span, 2100-ft. tram. West of this tram two others, one of 2400, the other of 4500 ft. connect other workings with the mill, the buckets having a capacity of 500 lb. The ore on reaching the mill is crushed by a jaw-breaker to 1½ in. and fed to two 10-ft. slow-speed Lane mills. No screens are used, the size of the product being governed by the height of discharge and amount of water fed to the pulp. Inside amalgamation is practised with excellent results. The pulp after being discharged, is split and passed over 5 by 10-ft. plates set on a grade of 1½ in. to the foot. From these it reaches two Barnes concentrators; thence to classifiers, and then to the cyanide-plant. Concentrate is shipped to the smelter, the slime at present is being impounded for future treatment. The cyanide-plant consists of four tanks—two sumps and two for solution, each holding 30-tons. The pulp is treated for four days, the gold being precipitated on zinc-shavings, dried, and shipped. Power for the plant is furnished by a 10-in. turbine under 54-ft. head, and

two small gasoline-engines of 25 and 16 hp. that are hooked-up to the same line-shaft. The approximate length of season for this camp is six months, and while the mill is forced to close down during the winter, the development-work in the mine is carried on and ore blocked out for the coming season. This year work commenced on May 25.

Another producer is the Independence Gold Mining Co., whose claims are situated on the head of Fishook creek. Two veins are mined on this property, one, the Granite Mountain, the other the Independence, both occurring in a formation similar to that of the Alaska Free Gold. On the Granite Mountain vein a drift of 265 ft. has been run. From the end of this drift an incline, flattening out about one-third the way down, has been sunk 480 ft. on the vein. Both overhand and underhand stopes have been opened from this, following the ore. Stulls support the roof, waste being used as pack-walls. Both veins strike N. 12° W. The dip of the Independence is 40°, the Granite Mountain dipping from 2° to 28° south-west. The Granite Mountain vein, up to the present, has been the most important one and that on which most of the mining and development work has been done. Two aerial-trams convey the ore to the mill. The ore passes over a 1-in. grizzly to bins, the oversize passing to a 7 by 9-in. Dodge breaker. From this it is automatically fed to a 3-stamp battery of 500-lb. stamps and one 1300-lb. Nissen stamp. Ore is crushed to pass 40-mesh, the pulp passing over plates set on a grade of 1¾ in. to the foot. Inside amalgamation is practised. After passing over the plates the pulp goes to an Ogden concentrator, thence to the tailing-pond. The report is that the capacity of this plant will be increased by the addition of a 5-ft. 6-in. Denver mill. The pulp, after passing over plates, will go to Wilfley tables.

A property on which more work is to be done this season is owned by the Mabel Mining & Milling Co. Open-cuts and drifts have been driven on the ore. A Denver mill of 15-tons capacity will be operated again this year. An aerial-tram, 3500 ft. long, is used to convey the ore from workings to the mill.

George B. Dean, of Spokane, representing Spokane capitalists and Trust companies, will spend several weeks going over different Willow creek properties. He will leave from Anchorage in company with E. R. Davidson, of the Mohawk Mining Co., to examine that property with a view of installing a mill.

Wm. Martin has arrived at Anchorage and will leave there for the camp at the Alaska Free Gold Mining Co., of Willow Creek, on May 27. Mr. Martin has plans under way to establish a central power-plant to furnish power to the other operators in this region.

The Cache Creek Co.'s new dredge will commence work for the season in a few days. This ground was tested by James Murray for three years before the dredge was installed. A dredge of 15,000-cu. yd. capacity was installed and run for some time last year. The pay in this district is from 3 to 12 ft. from the surface. The property consists of 75 or more claims. No information is at hand as to the value per yard.

The report of a strike in the placer district near Nenana, known as the Brooks section, is current. Nothing definite regarding the value of the ground has as yet reached Anchorage.

KOWKASH DISTRICT, ONTARIO

A New Gold District in North Ontario That Gives Signs of Promise for the Near Future.

Interest in the Tashota section of the Kowkash gold area is increasing, and there is every indication that this summer will witness much activity there. It is over twenty months since gold was first discovered in the Kowkash district, and due to the fact that the camp was isolated from any mining town, being 300 miles from Porcupine, and about 400 miles from Cobalt, development did not proceed with vigor. However, the one property developed, by the Tash-Orne Mining Co., has stood up well under actual test. The main shaft is down 115 ft., and at the 100-ft. level driving both ways is going on. These drifts are now out over 100 ft. each way from the shaft and the vein, in which considerable free gold occurs, is the full width of the drifts. Also, the wall rock on either side of the vein carries gold for several feet back from the vein. This company also owns the King Dodds property, which it is preparing to explore. The small mining plant in operation at the Tash-Orne will perhaps be removed to the King Dodds and a larger plant installed at the Tash-Orne.

Two other properties being developed in a small way are the Hull-Kipper group, and the Wells claims. On the former, the owners, who are prospectors, remained on the ground during the past winter and sunk a shaft 50 ft. deep on a large zone of schist intersected with small quartz stringers. The stringers are rich in gold, but when averaged with the rest of the mass, the rock could scarcely be termed of commercial value. However, the property is likely to receive extensive development before long, with a view to finding, if possible, better ore at depth. Despite the fact that snow is still deep in the valleys and swamps, quite a number of prospectors are already on the Kowkash trails.

PLATTEVILLE, WISCONSIN

A Number of Promising New Discoveries.—Old Mines Being Re-opened and Increased Production is Anticipated.

The Hazel Green district showed a slump in ore production, mainly through decreased shipments of ore from the Kennedy mine, one of the New Jersey Zinc Co.'s producers, which, however, recovered itself toward the last of the month. The McMillan Zinc Co., after two years of development got down to milling operations in the rebuilt Board of Trade mine equipment. Good strikes were reported in a score of borings on the lease held by the Rio Mining Co. The Cleveland Mining Co. made light deliveries most of the month from both of its producers, the Cleveland and Lawrence mines. From the Potosi camp came a car of high-grade concentrate each week from the Wilson mine. The Tiffany Zinc Co., with a new producer and a 500-ton mill was slow getting into action, but picked up toward the close of the month. Drillers were meeting with success on the Horse-Shoe lease where a new shaft was bottomed in zinc ore with a fair deposit of lead ore in the top openings. Several cars of lead ore came from that district during the month. The Galena district suffered set-backs in output, the Black-Jack mine, a New Jersey Zinc Co.'s producer, returning about one-half the usual output. The Graham and North Unity mines, Vinegar Hill properties, did well the second half of the month. J. H. Billingsley, president of the Frontier producers, and mayor of the city of Galena, purchased the Merry Widow mine that had been idle two years, and the plant was steamed up and dewatering of the workings began. Its operation now depends on a thorough inspection of the ore deposits which it is known were not entirely exhausted when the mine suspended production. It was proposed in the event this inspection should not meet expectations that a thorough drilling programme be inaugurated. Other mines will be taken over by the same interests when this property is again in operation.

KOREA

The following results for February has been received by mail from the Oriental Consolidated Mining Co.: 200 stamps, running time, 26½ days, crushing 23,885 tons.

Gross receipts for the month	$132,443.20
Operating costs	82,683.71½
Operating profit for the month	$49,759.48½
Put back into improvements and development work	2,929.12
Net profit over all expenditures for February	$46,830,36½

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

ARIZONA

Gila County

With its full milling capacity in operation for a large part of the month and the high recovery from ores treated, a new production record was established in May by Inspiration Consolidated Copper Co. at 11,900,000 lb. of copper. Although constituting the highest monthly yield to date, the May total was but slightly in excess of that of September 1916 output of 11,850,000 lb. when there were but 18 available mill sections. At that time, however, the grade of ore treated was higher than of late. During May, the average grade of ore at times ran below 1% copper, but the mill operations were so efficient and the tonnage milled so large that it more than offset the conditions in September. The management is figuring upon a monthly copper production exceeding 12,000,000 pounds.

Yavapai County

The Arizona Central Mining Co., of Houston, Texas, has taken an option on two groups of claims, at Copper Basin, that are owned by Fred Williams, Joseph Hobbs, and others, of Prescott. There are several shafts on the property, sunk on veins 3 to 10 ft. wide carrying gold, silver, lead, copper, and zinc. The property is near that of the Commercial company, one of the Phelps, Dodge subsidiary companies.

Yuma County

(Special Correspondence.)—One of the most promising new mining districts, is the region tributary to the Arizona and California railroad, from Wickenburg to Parker, a distance over 100 miles. One of the most active of the small towns is Wenden, the outfitting point for Cunningham Pass, 12 miles north. The Cunningham Pass mines have came into prominence only within the last year. The last few months two properties have been developed, the Black Giant and the Wenden King. Both properties have installed machinery and started to sink. The Black Giant is said to be completely financed to sink to the sulphide zone. A camp has been built, a hoist installed, and a compressor is said to be on the way. The Wenden King has just finished installing a hoist and compressor. Another company, the Wenden Verde, has recently entered the Pass district and it is reported it has ordered machinery, which is expected to arrive in a few days. The property which has shipped the most ore from this district is the Critic. The last car netted the leasers over $100 per ton. The Black Reef Copper Co. also has installed a new plant with a capacity to sink over 500 ft. A compressor also has been put in. It is the intention to do deep mining.——The Wenden Copper, is another property, which started development work in the last year, with 20 men working continuously. Originally all of these properties were owned by prospectors who chlorided the surface ores of unusually high-grade in copper and gold, and while not a great amount of ore has been shipped, there has been more ore shipped for the amount of development work done than from any other district in this part of Arizona.——Other properties are the Bullard, the Desert Mining and Development Co., and the Rainer. The Bullard property has been leased and bounded to Mr. Donnely, who recently had charge of the Wenden King. Mr. Donnely was formerly with the Goldfield Consolidated. The Bullard has shipped 28 cars of high-grade from surface adits. The Desert, which has been closed down temporarily, is going to resume operations soon. The workings are not down to water-level yet. It is said that there is over 40 ft. of low-grade copper ore in this mine. Considerable money has been spent in opening up this property, and some think that this expenditure more than justified the expectations.——The Rainer company has planned to drill its property either by churn or diamond drills.

Wenden, June 14.

CALIFORNIA

Amador County

(Special Correspondence.)—It is reported that some Kansas promoters are engaged in sampling the Tierakoff mine with a view of early re-operating. The Tierakoff is an extension of the Sawyer claims. It was worked many years ago. The mine is across the Mokelumne river, from the Lone Star mine in Calaveras county.——The Newman mine is steadily producing and everything is said to be satisfactory to the owner.

West Point, June 15.

Calaveras County

(Special Correspondence.)—The Buffalo Gravel mine in Chile gulch, about a mile from Mokelumne Hill, is erecting suitable buildings for accommodating the men at the mine. They are installing a 10-hp. Dow electric pump, which recently arrived. This looks promising and will, no doubt, encourage others in the near future to follow this enterprising example. The Safe Deposit gravel mine, also in Chile gulch, has had an entire change of staff, Wm. Burgess having sold his interest in the mine. An expert pipeman to lay all the necessary pipe, arrived from San Francisco recently.——Major Rand, of the United States Engineers, was up on business connected with the water and debris-dams of placer-miners.——The Corral Flat gravel mine, formerly known as the McKee and McGaw, near Mokelumne Hill, will start with a full force in the near future. The directing engineer is at present in the East. Driving to catch the channel is in progress.——The cross-cut adit of the Hector drift-mine is now in 3800 ft. Mr. Chapman, the superintendent, who was for over a year at the Greenwater, in Death Valley, had an automobile accident at Tracy, when the steering-apparatus broke.——The Lucas quartz mine, situated near the Mokelumne river, and consisting of five claims, is uncovering rich ore, some of it going as high as $500 per ton. An average of $50 per ton is obtained. The mine has produced considerable in the past, but the former owners missed the rich shoots. Robert Irvine, of Mokelumne Hill, owns three of the claims. The Mokelumne Hill group is running the mill, two shifts, on ore from the west-adit stopes; the ore is sulphide in diorite. The east and west veins carry the value.——The Boston, or the Esperanza, owned by Sam Davidson, of Mokelumne Hill, is awaiting the arrival of a Mr. Baker from San Francisco.——The Maypole quartz mine is practically at the end of the caved ground. Much re-timbering had to be done to catch it up, but it was finally accomplished. Leonard G. Blakeman, of Stockton, is superintendent.

Mokelumne Hill, June 12.

(Special Correspondence.)—P. B. R. Lightner, of Stockton, is steadily sinking on the La Petite quartz mine near this place. The ore that was struck at the 100-ft. level is holding up in value.

Railroad Flat, June 15.

Sierra County

H. L. Johnson has received the final payment on account of

the transfer of the Tightner mine, and it is reported that the present owners also distributed a dividend in May among those interested.

The Bernhardt Bros. are credited with having washed nearly 107 oz. of gold from 600 cars of gravel at their Hilo mine. This is at the rate of over $3 per car. There remained about 400 cars more in the block of ground from which the clean-up was made—a pillar left in the working by old-time miners, but the ground caved, cutting them off from the pillar, and a drift had to be run around the caved ground to get into new territory.

John Addison was injured recently at the Brandy City hydraulic mine in a peculiar way. He was in charge of one of the monitors, and was directing the stream against the gravel when lightning struck the pipe-line, followed the pipe to the monitor, and knocked the miner down. After recovering somewhat from the shock he started to walk to the blacksmith-shop, when another and heavier flash struck the bank and brought down several hundred tons of volcanic cement overlying the channel-gravel. Addison was hit by a large boulder rolling down from the shattered mass of rock, and injured more seriously than before. In addition to these injuries he was nearly drowned by a flood of water from a 22-in. water-pipe that was broken by the fall of the cement. He is back at his post again, having fully recovered from the several injuries of his eventful day.

SISKIYOU COUNTY

(Special Correspondence.)—M. A. Delano, of Grants Pass, Oregon, who owns the Bon-Ton group of four copper claims on Ike's gulch, or Slater creek, and who bonded the Mohawk and Copper King, has commenced development on these two properties.

David Land and C. J. Tuey, of San Francisco, who have been prospecting the Williams Brothers' placer diggings along the Klamath river, at Wingate creek, have completed their work.

Joseph Kinash, hydrographic engineer, of the United States Geological Survey, is taking measurements of discharge in Klamath river and Indian creek, also in the Reeves Davis Consolidated Mines Co.'s flume.

Harry Morrison and James G. Gallagher, of Philadelphia, Pennsylvania, are among mining men to arrive lately in this camp.

Alvin Smith and T. C. Ince are building a bridge across Slater creek in Wood gulch, to be used for hauling logs to their mill, and supplies to the mines in the Ike's Gulch district.

Mr. Kernor, superintendent of the Grey Eagle mine, is moving the office effects of the mine to new quarters on Indian creek adjacent to the mine. Two diamond-drills have been constantly developing the orebodies of the Grey Eagle mine for the past three months.

Earnest Helliare, of Grants Pass, and New York, is expected to arrive in Happy Camp to develop several copper properties in this district.

Local people are deevloping a number of promising copper claims of the Commodore group near the headwaters of Barkhouse creek, a tributary of the Klamath river.

Prospecting is active throughout this district. There are many prospectors in the hills, also prospective buyers of promising claims. Among the recent arrivals at the camp are Jesse Gorden, of Bakersfield, California; J. E. Perry, of Riddles, Oregon; Henry Phillips, of Oakland; George Thompson, of Reno, Nevada; M. White, of San Francisco; and Harry Wayland, of Ogonze, Pennsylvania.

Henry Doolittle, a merchant of Seattle, has arrived in Happy Camp, and will take up his residence here for a short time to adjust the affairs of the Doolittle estate, of which he is the administrator. The estate owns the Camp site, and adjacent lands. He will have the property laid out into town-lots, providing for commodious thoroughfares and parks essential for the needs of a modern city. This meets the wishes of the residents of the little town.

John F. McCoy has a large force of men employed in making trails up Slater Creek gulch, and the Dakin ridge to Slater gulch. An early survey will be made of this property and a camp built. The property lies to the east of the Grey Eagle mines and adjoins that property.

Happy Camp, June 15.

COLORADO

BOULDER COUNTY

(Special Correspondence.)—The Dupont-Wooding company, at Denver, has taken the Huron mine under lease and option and will begin systematic development. The General Lee mine, an adjacent property, owned by Mrs. S. A. Martin, it is reported has passed into other hands, and will be worked. This property has a fine body of ore exposed in the face of the adit. Otto Victor and associates have a splendid showing of silver-lead ore in their property on Tennessee mountain. When the Consolidated Leasing Co., of Columbus, Ohio, of which C. E. Kahler is president and general manager, gets its mill built, the mining industry at Eldora will be given an impetus which will result in many good old properties that are now idle, being opened up, and steadily worked, thanks to custom-mill, as high cost of freight heretofore has prevented many properties from shipping. The Good Friday mine, at Boulder Falls, which has been a steady producer of tungsten ores the past year, is getting ready to work one of the largest blocks of ore in the county. The management has now developed the mine to a stage where the natural disadvantages of the situation will be overcome and a constant production of ore will be made. N. H. Brown is general manager, and C. W. Roche is foreman. The Good Friday vein, which is a part of the lower vein that runs through the Eureka, Luckie 2, and April Fool properties, has differed from most tungsten deposits in that it has produced pockets; but the vein has been practically continuous throughout the entire development of all of these mines. This property is one of the claims of the Mojave-Boulder Tungsten Co., a New York concern. J. N. Baer has a lease on the April Fool mine, one of the properties in this group. Brown and Lewis have begun unwatering their mine at Loveland and intend starting development. The Red Sign Company, in Millionaire gulch, is resuming operations on its properties. The Logan mine has been taken over by the Lucky Dick Mining Co. The new company will do a large amount of development work. The Eureka mine has been leased to operators who will begin work promptly.

Eldora, June 13.

IDAHO

SHOSHONE COUNTY

The Success Mining Co. will resume dividends at an early date is the announcement authorized by P. J. Gearon, the manager. The large orebody that has been developed on the 1400 and 1500-ft. levels has placed the property in fine position for production, and shipments are being made at the rate of 2000 tons per month. The shaft has been sunk to the 1600-ft. level and a skip-pocket cut. Cross-cutting to the ore will begin which is expected to be reached by the middle of June.

According to the statement of F. W. Bradley, president of the Bunker Hill & Sullivan company, it is the intention of the company to begin the construction of an electrolytic zinc-refinery as soon as the new smelter is in operation, says the Wallace *Miner*. The Bunker Hill & Sullivan is not a producer of zinc ores, but there is an abundance of zinc ore in the district, and a refinery such as is now proposed would afford a local market for ores of this kind. The elimination of the cost of transportation for ore to outside zinc plants would be welcomed and would make it possible for some mines in which

zinc occurs, which are now struggling for an existence or idle, to work at a profit.

The initial capacity of the new plant will be 300 tons per day. It is to be situated near the smelter and will be planned with a view to enlargement.

MICHIGAN

Houghton County

Every man that can be spared from actual production work is being used by the Lake Superior copper mines on the biggest construction program ever undertaken. The mine managers are putting many thousands of dollars into work which will lower production costs in the future, says the Boston *News Bureau.*

The Mohawk, Wolverine, Quincy, and Calumet & Hecla have started work on fire-sprinkler systems in their mills. Mass Consolidated is increasing its mill capacity, the Mohawk-Wolverine mills are installing an expensive new turbine and new launders; a turbine is going in at the Ahmeek mine; Calumet & Hecla is adding a new 12,000-kw. turbine to operate the new electrical tramming and mining-devices recently installed. Isle Royale, Adventure, Mass, Lake, Ahmeek, Keweenaw Copper, and Osceola are building new houses for employees, and many mines are adding new shops, and the Tamarack mill is being enlarged.

The Chilean mills at the Calumet & Hecla re-grinding-plant No. 1 are being replaced with Hardinge conical-mills. The Calumet & Hecla is planning to build a big flotation-plant and is increasing the capacity of its leaching-plant from 2000 to 4000 tons daily. The Calumet & Hecla is spending thousands of dollars on its Torch Lake plant to recover a higher percentage of copper and to treat its great pile of tailing. Many mines are also spending money on mechanical-haulage and working out intensive mining systems whereby more rock can be mined and hoisted per man employed than was customary under old systems.

MONTANA

Lewis and Clark County

(Special Correspondence.)—At the property of the Marysville Gold Mining & Development Co. work has been in progress since last fall, the result of which is a large tonnage in sight, and it appears only a question of time when works will be built to treat the ore of this mine. The value is still all in gold and much of the ore blocked out is free-milling, some of it being high-grade.

Marysville, May 22.

Silver Bow County

(Special Correspondence.)—The North Butte output for the month of April was 1,911,763 lb. of copper, 94,769 oz. of silver, and 123 oz. of gold. This is a big falling off from the March production and was caused by the fire at the Modoc mine of the Anaconda company.

The Speculator shaft is being re-timbered and will be ready for use about the first of June. When this has been done it is expected to bring the production of the Granite Mountain and Speculator mines up to 3,000,000 lb. of copper per month.

At the Bonanza mine of the Anaconda company record time is being made in shaft-sinking. Only three men are working in the bottom and these men have sunk 490 ft. since January 2.

Butte, May 22.

Granite County

(Special Correspondence.)—Butte men have taken over the Swastika mine. It is planned to sink to the 500-ft. level and cross-cut the property from that point. The company is installing new machinery and in the meantime will continue to ship from the orebodies that are opened up. The Granite-Bi-Metallic property is working 200 men, and the manganese mines are booming; several companies are at work taking out manganese ore on which there is a big profit. The agents of Eastern concerns are paying as much as $10 per ton for the ore at the mines.

Phillipsburg, May 22.

NEVADA

Eureka County

(Special Correspondence.)—Ore has been found on the lower levels in the California mine, by J. Robealati, the manager, who has been running a cross-cut to open up the orebody which was known to exist at depth. A 4-ft. vein of 56 oz. silver ore has been opened up in the Mt. Hope district by Ben Repetto, and associates.

Eureka, June 14.

Esmeralda County

The production of the Goldfield Consolidated mines during April was 27,000 tons of ore, from which a net profit of $15,007.32 was realized. During that month development was done to the extent of 1501 ft. at a cost of $5.66 per foot.

The operating costs were as follows:

	Ore handled, per ton	Total ore, per ton
Mining:		
Stoping	2.381	....
Development	18.828	....
Total mining	2.710	$2.262
Leasing expense	2.688	0.057
Dump moving	0.407	0.056
Transportation	0.067	0.067
Milling	2.022	0.016
General expense	0.287	0.287
Bullion tax	0.013	0.013
Filter royalty	0.025	0.025
Flotation royalty	0.146	0.072
Surface	0.054	0.054
Total operating costs		$4.931
Miscellaneous earnings		0.062
Net operating costs		$4.869
Construction		....
Net costs		$4.869

Development of Main Levels

Mohawk: On an intermediate, above the 350-ft. level, 202EXY sill was extended and produced 34 tons of $13.02 ore. On the 350-ft. level, 380 ft. north from the shaft, 215SZ sill was extended and produced, 63 tons of $11.92 ore.

Laguna: On the 600-ft. level, 650 ft. south-east from the shaft, 450-M winze was sunk and produced, 127 tons of $47.75 ore. There was no development of ore of any importance in any of the other mines.

Lessees: During the month lessees produced 576 tons having a gross value of $8571.49, of which the company received $5436.78, less the cost of transportation and milling.

Humboldt County

The De Soto group of mines, 10 miles south of Mill City, is to be re-opened, according to the Lovelock *Miner.* The company will be known as the De Soto Consolidated. A great deal of rich ore was mined at the De Soto, Sheba, and other mines of that vicinity in the early days, the high-grade being hauled by teams over the Sierra Nevada mountains to Sacramento, and then shipped by boat or railroad. The value was chiefly in silver, and some of the ore was worth over $1000 per ton.

White Pine County

(Special Correspondence.)—Chas. Ruden has sold the old Maryland mine which he has owned and worked for the past 10 years to Robert Kelley, one of the owners of the California mine near Eureka. The new owner has bought a Blake crusher and will put in a jig and work the old dumps. He will

also put in a small hoist and a pumping-engine to furnish water for concentrating. The Maryland has been a producer for many years. The first ore taken out was shipped to Swansea, Wales, for treatment.

Eureka, June 12.

NEW MEXICO

Socorro County

(Special Correspondence.)—Metal production by Mogollon Mines Co. for first half of May was 14 bars gold-silver bullion, in addition to which three tons of high-grade concentrate was shipped to the smelter.

Re-timbering of the Deep Down shaft by The Oaks company is rapidly proceeding and it is the intention to install an electric pump, as the work will shortly be down to water-level. At the Maud S. mine the continued opening of good mill-ore in new places is meeting the expectations of the company. All available burro-trains are being employed in daily shipments to the custom-mill.

The construction of a tailing-flume by the Mogollon Mines Co. has reached a point below the Maud S. property, where the canyon is narrow, with perpendicular walls, and the flume is being suspended by cables, anchored to either side of the cliff.

Auto-trucks are being utilized in macadamizing the grade over the mountain. Where the road has been finished it gives promise of permanency in all kinds of weather.

Mogollon, May 31.

(Special Correspondence.)—The Socorro Mines Co. cleaned up 1800 lb. of bullion for the last half of May, making nearly two tons of gold-silver for the month. Work has been about completed on the main Silver City road over the mountain. A good covering of crushed rock has been used, this being brought from the mines by trucks. The Oaks Company continued to increase operations during the week. More burros have been secured for Maud S. ore-shipments and ore is steadily being shipped to custom-mill. New ground is being opened up which is proving satisfactory to the operators, the grade being well above the camp-average. Work on the tailing-flume is being pushed as fast as lumber can be had. Development work on the Trilby group is being carried on by the owners. Good ore has been opened and is being developed.

Mogollon, June 15.

OREGON

Baker County

A rich strike in the Irondyke mine at Homestead in announced. According to the common report a body of copper-gold ore has been cross-cut 125 ft., the ore of which assays 5% copper, $12 in gold, and 2 oz. silver per ton. After a long idleness the Irondyke mine was re-opened in 1915, since which time it has shipped to smelters over 30 cars of ore monthly, from the proceeds of the sale of which the company has paid off the purchase price of the property, $600,000. The principal development is a 3-compartment shaft sunk from what is known as the west adit-level. The newly discovered orebody is 850 ft. from the surface. It is supposed that the ore will extend both upward and below the level at which it has been exposed. No driving has yet been done so the length of the shoot is unknown. The property is under lease and option to the Irondyke Copper Co., of Pennsylvania, of which F. F. Curtze is president, F. A. Brevelier is secretary, and A. A. Claus is treasurer, all of Erie, Pennsylvania. Emmett Gilligan is superintendent.

Jackson County

(Special Correspondence.)—Asbestos in limited quantities has been uncovered at times and at various points in this region, but it has been of too short fibre to prove of commercial value. Recently, however, a deposit of long-fibre asbestos has been located in the Shelly Creek mining district, below Grants Pass. The extent of the discovery has not been demonstrated. The best developed asbestos property in Gold Hill district is situated on the south slope of Cedar mountain, on the Umpaqua divide at the headwaters of the West Fork of Evans creek, 20 miles north of Gold Hill. It was developed by George Houck, and Irvin Ray, of Gold Hill, 10 years ago. The vein is 4 ft. wide. It is at an elevation of 4000 ft. The fibre runs from 10 to 16 in. long and is of fair commercial value. It is 12 miles to the terminal of the wagon-road leading to this valley, which is the only outlet. Recently there have been many inquiries in this district regarding asbestos.

Another auto-truck was added this week to those hauling copper ore from the Blue Ledge mine to Medford, making 14 to arrive from California, all of which are in service. The road is in bad condition, making the transportation of ore slow and expensive. Improvements are contemplated by the county, assisted by the mine and truck owners.

In Douglas county, near the Jackson county-line, a few miles from Tiller postoffice, a promising vein of cinnabar is being uncovered on the Webb-Hayes property. This prospect seems to be an extension of the large dike carrying cinnabar, which runs through the Ramsey canyon and Meadows districts, north of Gold Hill.

Those who have visited this district of late have found that the chrome deposits, especially those in the Waldo district, are of sufficient importance to justify development. It is assumed that for a number of years the deposits in this region will be a source of profit and a field for numerous laborers.

Reorganization and refinancing of the Rogue River Public Service Corporation, of Gold Hill, was forecast last week when, upon the petition of Francis M. Fauvre, vice-president of the company, Federal Judge Wolverton, at Portland, appointed J. F. Reddy and George M. Soranson, of Grants Pass, joint receivers. The Rogue River Public Service Corporation owns important water-power rights in southern Oregon on Rogue river, including the huge Ament dam, situated between Gold Hill and Grants Pass, and a completed wing-dam power development project at Gold Hill. The reorganization is of much local interest, as the company has been of vital importance to the mining industry in this district in the past. The company operates the municipal water-plant of Gold Hill under lease.

Gold Hill, June 14.

SOUTH CAROLINA

Abbeville County

The Sullivan Mining Co is operating a 50-acre tract three miles from McCormick. The main shaft is down 110 ft., and in a cross-cut at the 60-ft. level 18 veins from 6 to 24 in. wide are said to have been cut. At 100 ft. a vein 4 ft. wide carries ore worth $10 per ton. A drift has exposed this vein for 20 ft. Ore of 20-oz. grade is reported from some of the smaller veins. The shaft has two compartments, with hoist and pump-way.

Ore is hoisted in a bucket and fed to a gyratory breaker, falling into the mill-bin, thence through automatic feeders to two 5-stamp batteries. Inside amalgamation is practised and a successful method for saving so-called greasy gold. Quicksilvered copper plates are used and the tailing runs to waste. The installation of two concentrating-tables is contemplated in the near future. A 45-hp. boiler furnishes steam for mine-pump and hoisting-engine. The whole plant is built in a miner-like way, and under the conditions seems to be an economical one.

TEXAS

Llano County

(Special Correspondence.)—W. B. Phillips, of the Bureau of Economic Geology and Technology of the University of Texas, in discussing the possibility of platinum ores being found in that State, says that a few years ago a company, while engaged in gold mining in Llano county, made a number of assays of a material found on the property which was thought to contain platinum. The results showed that a maximum of 0.42

oz. and an average of 0.24 oz. of platinum per ton of rock was contained in the ore. The platinum is associated with a little gold and bismuth, possibly as telluride of gold and telluride of bismuth, and to exist as the arsenide of platinum, known as sperrylite. The experimental work resulted in the production of an alloy of platinum and lead, the content of platinum being about 70% of the alloy. So far as known this is the only important occurrence of platinum in Texas. Much still remains to be done before anyone can venture to express an opinion, at the same time the occurrence of platinum in this State is interesting. In Llano county the platinum occurs in quartzite closely associated with the graphite-bearing schists at the Heath gold mine, five miles east of Llano. Platinum also occurs there in granite and hornblende schist overlying the granite. The old shaft is in bad condition. On the same property there is an extensive deposit of flake graphite, together with molybdenite and molybdite.

Llano, May 27.

REEVES COUNTY

(Special Correspondence.)—The development of the sulphur deposits of western Texas are beginning to assume increasing importance. The recent incorporation of the United States Sulphur Co., with a capital stock of $600,000, and general offices at Dallas, is taken to mean that there will be a large increase in the output of refined sulphur from this region as soon as the company can install the necessary machinery and equipment. It will build a large sulphur refinery, and besides removing the impurities from the crude material it will manufacture sulphuric acid. The men who compose this company have been carrying on exploration work on their sulphur deposit for several months and have uncovered upon a tract of 40 acres sulphur amounting to more than 2,000,000 tons. At present prices, even for the crude ore this mineral in sight is worth a large amount. The sulphur outcrops in many places over a large area of country besides that which has already been partly explored.

Toyah, June 4.

CANADA

COBALT, ONTARIO

(Special Correspondence.)—The Nipissing Mines Co. has declared its regular dividend of 5% payable July 20 to shareholders of record June 30. This means the disbursement of $300,000, and brings the total paid so far during 1917 up to $900,000, and a total since the initial disbursement, of $16,246,000. This is equal to 264% on the company's issued capital.

Cobalt, June 11.

MEXICO

(Special Correspondence.)—The revival of mining operations in the Cananea and Nacozari districts of Sonora, is shown by the custom-house figures of the exports to the United States during the month of May of ore, concentrate, and bullion. From the Cananea district there were sent into the United States during May 5,407,600 lb. of copper and 16 cars of copper, zinc, gold, and silver ores, having a total value of ₱4,163,400 gold. From the Nacozari district the concentrate for the month had a value of ₱2,019,700 gold. It is expected that the exports from those districts for June will be larger than in May. There promises to be also heavy shipments of concentrate and bullion made from other districts in Mexico where the operation of mines and mills has been resumed recently. They will come principally from the Monterrey region with the possibility that some of the districts in the states of San Luis Potosi and Zacatecas will also become shippers.

Cananea, June 12.

WASHINGTON

The Boston American Mining Co. is planning a 200-ton mill for the Monte Cristo mine, at Monte Cristo. H. deS. Kennedy will have charge of the construction.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

J. PARKE CHANNING has returned to New York.

A. M. BATEMAN has gone to Kennecott, Alaska.

H. P. GORDON has returned from Chichagoff, Alaska.

J. D. IRVING was in the Coeur d'Alene region recently.

J. M. BOUTWELL and E. S. BASTEN are in South America.

F. W. BRADLEY was at Portland, Oregon, during the week.

L. D. RICKETTS is recovering from the effects of his recent illness.

ERNEST R. WOAKES has returned to London from the Argentine.

R. S. BAVERSTOCK has returned to Los Angeles from a trip to Lida, Nevada.

ROSS B. HOFFMANN is examining dredging conditions in the Yuba goldfield,, California.

D'ARCY WEATHERBE is due here from Toronto. He will sail on the 'Tenyo Maru' on June 29.

W. W. MEIN has arrived here from New York, expecting to spend the summer at Lake Tahoe.

ROBERT C. STICHT will address the San Francisco section of the A. I. M. E. on July 10, on 'Pyritic Smelting.'

PAUL W. AVERY is here from El Oro, Mexico, on a short visit.

C. E. GRUNSKY, JR., has resigned the secretaryship of the local section of the A. I. M. E. owing to his military duties.

R. H. STEWART, formerly manager for the Consolidated Mining & Smelting Co., at Trail, B. C., has opened an office as consulting engineer at Vancouver.

VALERIUS, MCNUTT & HUGHES have opened an office in the Fayette National Bank building, at Lexington, Kentucky. They will specialize in petroleum geology.

H. N. STRONCK has been appointed vice-president and managing engineer of the Illinois Engineer, Auditing, and Public Relations Co., 122 S. Michigan avenue, Chicago, this firm being successors to Benedict, Boyle & Stronck.

HENRY S. MUNROE, emeritus Professor of Mining in Columbia University, has been awarded the medal given by the class of 1889 for the most distinguished piece of work done by a graduate of the Schools of Mines, Engineering, and Chemistry.

Obituary

ALFRED HOFFMAN PINTHER died May 22. He was the senior member and president of the firm of Hoffman Pinther & Bosworth, of Mexico City.

EUGENE H. T. CHEN, a graduate of the mining college of the University of California, came to his death in the Province of Yunnan, China, recently, as a result of a forest-fire, thought to have been started by brigands. Mr. Chen, upon graduating from the University, returned to his native land and engaged in his profession in Yunnan. He is described by his friends as a man of marked ability, and his death will be greatly regreatly regretted by all who know him in California.

On April 17, WILLIAM SWANCOTE, the pioneer of zinc mining at Hanover, New Mexico, died at his home in Hanover. A week previous to his death he received a severe fall; later pneumonia set in, from which death resulted. Mr. Swancote was born in Wales, in 1844; and came to Central City, Colorado, in the early 70's, and in 1884 went to New Mexico for the Mineral Point Zinc Co., for which company, and its successor, the Empire Zinc Co., he was superintendent of mines until 1915. Mr. Swancote represented the highest type of manhood; he was an honor to his company and to the mining industry. All who knew him called him friend, and his passing will be mourned by the great company in which he was so many years an important factor.

THE METAL MARKET

METAL PRICES

San Francisco, June 19

Antimony, cents per pound	19.50—22.00
Electrolytic copper, cents per pound	34.50
Pig lead, cents per pound	12.25—12.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$82
Spelter, cents per pound	11.50
Tin, cents per pound	59
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, June 19

Antimony, 50% metal, per unit	$1.35
Chrome, 40% and over, f.o.b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tin, cents per pound	60
Tungsten, 60% WO_3, per unit	20.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 45% (under 35% metal not desired), cents, unit	36—38

Manganese prices and specifications, as per the quotations of the Carnegie Steel Co. schedule of prices per ton of 2240 lb. for domestic manganese ore delivered, freight prepaid, at Pittsburg, Pa., or Chicago, Ill. For ore containing

	Per unit
Above 49% metallic manganese	$1.00
46 to 49% metallic manganese	0.98
43 to 46% metallic manganese	0.95
40 to 43% metallic manganese	0.90

Prices are based on ore containing not more than 8% silica nor more than 0.2% phosphorus, and are subject to deductions as follows: (1) for each 1% in excess of 8% silica, a deduction of 15c. per ton, fractions in proportion; (2) for each 0.02% in excess of 0.2% phosphorus, a deduction of 2c. per unit of manganese per ton, fractions in proportion; (3) ore containing less than 40% manganese, or more than 12% silica, or 0.225% phosphorus, subject to acceptance or refusal at buyer's option; settlements based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken to be deducted from the weight. Prices are subject to change without notice unless specially agreed upon.

EASTERN METAL MARKET

(By wire from New York)

June 19.—Copper is easier but dull at 32.75 to 32.50c. Lead was quiet and strong all the week at 12c. Zinc is quoted at 9.75 to 9.67c. Platinum remains unchanged at $105 for soft and $111 for hard.

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
June 13	77.00	May 8	74.92
" 14	77.00	" 15	74.69
" 15	77.00	" 22	74.78
" 16	77.00	" 29	74.62
" 17 Sunday		June 5	74.80
" 18	77.00	" 12	75.83
" 19	77.00	" 19	77.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	72.51	Oct.	49.40	67.86	....
May	49.87	74.27	74.61	Nov.	51.88	71.60	....
June	49.03	65.04	....	Dec.	55.34	75.70	....

Samuel Montagu & Co. in their weekly letter, dated London, May 24, say of silver: The tone of the market continues to be remarkably steady and the price has moved again within very narrow limits.

Since May 2nd last, the quotation has never been more than ⅛d. either side of 38d. From May 10th on, it has been either at 37⅞d. or 38d.

There has been an absence of business from the East; buying orders have been mainly for coinage as usual.

There has been a considerable drop in the Indian price. It fell in Bombay from 103¾ to 100¾, duty paid, following the collapse of a local corner for delivery. The fact that the price has been moving above 100 rupees per 100 tolas is suggestive, and throws a light upon the bearish attitude of the Indian Bazaars, which has obtained for some time past, and also upon the way in which the Indian people have been content with such reduced imports for industrial consumption.

It is more than probable that many individuals whose silver jewelry depreciated seriously when the Indian mints were closed to free coinage, have taken advantage of the high prices, compared with those ruling for the last 20 years or so, and have turned their silver bangles into silver coin. This action would account for a proportion, though probably slight, of the excessive drain demand for silver rupees during the last two years.

The figures relating to the Indian currency show a large increase in the note issue, and for the first time since March 31 last an increase in the silver holding by the Treasury.

The stock in Bombay consists of 2000 bars, as compared with 2200 bars last week.

The stock in Shanghai on May 19 consisted of about 26,600,000 oz. in sycee and $17,500,000, as compared with about 29,000,000 oz. in sycee and $17,700,000 on April 12.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
June 13	32.75	May 8	31.37
" 14	32.75	" 15	32.00
" 15	32.75	" 22	32.25
" 16	32.75	" 29	32.50
" 17 Sunday		June 5	32.62
" 18	32.50	" 12	32.75
" 19	32.50	" 19	32.58

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.02	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	33.16	Oct.	17.90	28.50	....
May	18.71	29.02	31.69	Nov.	18.88	31.95	....
June	19.75	27.47	....	Dec.	20.67	32.89	....

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
June 13	12.00	May 8	9.62
" 14	12.00	" 15	10.49
" 15	12.00	" 22	10.50
" 16	12.00	" 29	10.93
" 17 Sunday		June 5	11.46
" 18	12.00	" 12	11.83
" 19	12.00	" 19	12.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	9.38	Oct.	4.62	7.02	....
May	4.24	7.38	10.29	Nov.	5.15	7.07	....
June	5.75	6.88	....	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound.

Date		Average week ending	
June 13	9.75	May 8	9.61
" 14	9.75	" 15	9.37
" 15	9.75	" 22	9.37
" 16	9.75	" 29	9.50
" 17 Sunday		June 5	9.66
" 18	9.67	" 12	9.75
" 19	9.67	" 19	9.72

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	9.05	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	10.20	Oct.	14.05	9.92	....
May	17.03	16.01	9.41	Nov.	17.20	11.81	....
June	22.20	12.85	....	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending

Date			
May 22	95.00	June 5	90.00
" 29	95.00	" 12	90.00
		" 19	82.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	51.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	114.50	Oct.	92.90	78.20	....
May	75.00	90.00	104.00	Nov.	101.50	79.50	....
June	90.00	74.70	....	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	48.25	51.49	55.63	Oct.	33.00	41.10	....
May	39.28	49.10	63.21	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

Arrangements are being made to simplify the distribution and control of tin, and these arrangements are expected to get the trade all the tin required. The prices have therefore shown a considerably easier tendency and the market is nominally quoted at 60½c. for spot delivery, with Banca and Chinese tin at a great discount. Banca has actually been done at 55 cents.

TUNGSTEN

The tungsten market is extremely firm, with very little offered, and at the present moment there is more demand than supplies, espcially for scheelite, which is practically sold out for early delivery. The market has been quite firm at schedule prices, with continuous inquiries for home and foreign consumption.

MOLYBDENUM

Molybdenite remains unchanged and firm at $2.20 per pound MoS_2.

ANTIMONY

Antimony has been exceedingly active during the past week, though at prices gradually declining, and spot antimony is quoted at 20 to 20½c.; August shipment, 15 to 15½c. Needle antimony is firm at 12c. for spot, with futures quoted at 9½c., which is a higher figure than before on account of the freight rates from China being continuously on the increase. Antimony ore remains unchanged with buyers at $2.30 per unit.

MANGANESE

The manganese market continues firm and $1 a unit was actually paid for high-grade ore f.o.b. New York. Chemical ore prices are unchanged.

Eastern Metal Market

New York, June 13.

All the metals are much less active than for some weeks, and are generally held in restraint by uncertainties due to the attitude of the Government and to other conditions.

Copper is quiet but firmer, especially for future deliveries.

Zinc is dead but firm.

Lead is higher but not active.

Tin is dull but steady and firm.

Antimony continues to decline in an inactive market.

In the iron and steel market pig-iron continues to rise and advances are recorded over the remarkable ones reported a week ago. Bessemer iron has sold for $55 per ton on small sales and basic iron has touched the $50 mark, an advance of $5 on sales of more than 50,000 tons. Melting steel scrap has sold at $42.50 at Pittsburg, an advance of $12.50 in two weeks. Rapid strides have been made in the ship-building program in the past week, and the project for a yard in the New York district, for which large steel interests will carry on fabrication on an unheard of scale, is rapidly taking shape under the lead of the Submarine Boat Co. Shell contracts for the Government total 9,000,000, requiring 80,000 tons of steel. On domestic ship-plate inquiry 11c. and higher has been quoted, and France is asking for 25,000 tons of plates and shapes for ship repair-work. The demand for both black and blue annealed sheets from automobile plants and other sources has reached large proportions. The entire steel trade is much at sea as to the future steel-supply for general consumption, and the lengths to which prices will go.

COPPER

Despite the fact that sales are in small volume for any position, and that demand is not large, the market grows firmer every day. In general, quietness prevails, but the market has come to a halt because of the long continued uncertainty regarding the purchases to be made by the Government and its allies, and the price to be paid. Nothing is yet known regarding these all-important facts, but it is believed that no actual decisions have been made. Metal for future delivery is stronger with each week, most of the larger producers having nothing to sell this side of August, and not much for August and September. Early deliveries are only obtainable through second hands and small dealers. The quotation for Lake and electrolytic yesterday was 32.75c., New York, with as high as 33 to 34c. asked for spot and prompt. Third quarter, outside of July, is pegged at 30.50 to 31c., with July at close to 32c. Last quarter delivery is quoted at 29 to 29.50c. London's price for spot eelctrolytic is unchanged at £142 with futures at £138. "As long as the war lasts there will certainly continue to be a large demand for copper," says a prominent New Yorker. "At the present time spot copper is scarce; there is little to be had. There is a big demand, too, for copper for late delivery. The shipping industry is calling for large amounts of copper, and their demand will undoubtedly continue even after the war. We cannot tell what will happen when peace comes. Germany, however, will be a large peace purchaser."

TIN

The obtaining and the allocation of tin supplies is at present the absorbing topic. A committee of consumers and importers is being formed which is to handle the entire situation in this country, provided its personnel and recommendations are satisfactory to the Government. The allocation of tin supplies will be in the hands of this committee and not in that of British agents in this country. The main concern of the Government is that adequate supplies be obtained and that they be properly apportioned. It is believed that satisfactory arrangements are to result from the negotiations between the two governments as to supplies, and the fact that the regulations are to be left practically to the trade, if satisfactory to the Government, are productive of good feeling and confidence. The market has been quiet the entire week, with price-fluctuations within a range of less than 1c. per lb. Yesterday the quotation was 60.62½c., New York. On Monday it was 60.75c., and on Thursday and Friday last week it was 61c. with sales at 60.50c. reported on Wednesday, June 6. Business in general has experienced a check due to the negotiations referred to, and to the duty question, which still hangs fire. More interest is shown in far-off tin, even at present high prices, but there is not much buying. There was a moderate business late last week in future shipments from the East. Arrivals up to and including June 12 were 540 tons with the quantity afloat 3356 tons. The London market is a little lower and quiet, the quotation yesterday for spot Straits having been £236 5s., a decline of about £3 from that of a week ago.

LEAD

Spot lead sold yesterday in New York as high as 12.50c. The market is, however, quieter but very strong. Prices continue to advance. The American Smelting & Refining Co. advanced its quotation twice in the past week. On June 6 it announced 10.50c. as its quotation, and on June 8, 11c., bringing the price a little nearer to the outside market, which also went higher, or to 12c., New York, and 11.87½c., St. Louis, yesterday. A meeting was held in Washington Monday at which it is believed the Government's needs for July and beyond were made known and provided for, but the quantity and price are not known publicly. Considerable interest is attached to this and the facts are eagerly awaited. Re-sale lots are fewer now than a short time ago. While consumers are in need of metal, they manifest no desire to buy, and are proceeding slowly. Reasonable offers, however, would probably be accepted despite the fact that supplies are really scarce. For July and August, 11.87½c., New York, has been bid, but no business has resulted.

ZINC

More or less confusion prevails regarding purchases of spelter by brass makers in particular who have Government contracts which have recently been awarded. There have been several inquiries for fairly large quantities of brass and other spelter. One of these resulted in a purchase of a goodly amount and soon after the sale had been made the purchaser was notified that the Government would furnish the metal and he was compelled to sell what he had bought. Another consumer was in the market for spelter for use in meeting a contract for one of the Allies, but was compelled to relinquish an option on a large block of metal owing to inability to learn whether he or the Government was to obtain the spelter. Because of such instances and other uncertainties the market is at a standstill and practically stagnant. Prices remain unchanged from last week with future delivery metal higher than prompt and nearby. The quotation for the former is 9.50c., St. Louis, or 9.75c., New York, with the latter obtainable at about ⅛c. lower, in some cases at the same price. The belief continues that ultimately a large Government demand, direct or indirect, will develop so that higher prices will result, or at least not lower ones.

ANTIMONY

Because of lack of demand the market has fallen in the past week until Chinese and Japanese grades are obtainable at 20.50 to 21.50c., New York, duty paid. The market for future shipment is more active, and one estimate places the sales for May to August shipments from the Orient at 700 to 800 tons.

Book Reviews

BRAZIL TODAY AND TOMORROW. By L. E. Elliott, F.R.G.S. The Macmillan Co., New York, 1917. Illustrated, pp. 338, index. Price, $2.25. For sale by the MINING AND SCIENTIFIC PRESS.

Brazil is a land of tremendous opportunity, with a future that is gradually coming to be understood in the United States. Its development has been slow, partly because of the commercial isolation imposed upon her during the colonial period, partly because she has not possessed the kind of mineral wealth that leads to a rapid influx of population with its reciprocal influence upon agricultural development, and finally because the difficulties of colonization, always present in a forested country, have been exaggerated in her case by a stupendous luxuriance of woodlands that have practically defied the ax of the pioneer, and which only long periods of gradual attrition can overcome. Nevertheless, this great virgin territory will in time be subdued to the service of feeding a world of nations more advanced in their manufacturing activities. Brazil is one of the great potential granaries of the earth, with an area equal to that of the United States, of which at least half is as well adapted to northern races as are the Gulf States in our own country. We have left so far behind us the early pioneer perils of the South Atlantic States that it is hard to realize the effect that clearing and draining of the land has had in making it salubrious, and that scarcely more than 150 years ago the Carolinas and Georgia were reputed to be particularly fatal to Europeans. The picture of Brazil presented by Mr. Elliott is brilliant and attractive. He is a competent observer, and approaches his subject as a man should, with enthusiasm, and with a critical but sympathetic understanding of the Brazilian people whom he describes. The introduction to the volume is unfortunate, but the worth of the book must not be judged by the bungling style of these first few pages. Once fully launched upon his treatise the author marshalls his facts in an orderly and incisive manner. He gives vivid pictures; his story of the political development of the country is swift and strong, the account of Dutch and English efforts at conquest and domination are interestingly presented, and the narrative of the strange adventures of the bandeirantes in their struggles to explore and exploit the great interior sertão is an impressive tale of one of the most peculiar and thrilling colonization-movements that the Western Hemisphere has witnessed. The later colonization from Europe is not dwelt upon at great length, and one will fail to find a full history of the turmoil and trouble brought about by the German immigration into the southern states of Brazil. The turbulence brought into the politics of the nation by these 122,000 Germans and their descendants, with the disasters attendant upon their ceaseless revolutionary attempts, is out of all proportion to their numbers, and the contrast between their influence and that of the other alien populations is noticeable when it is considered that the world has barely heard of the 104,000 Russians who settled in Brazil, nor of the 1,360,000 Italians who have found home and prosperity in that country without disturbing the established social order. Mr. Elliott has written a readable handbook of the republic, which should be the *vade mecum* of every visitor, and should be read by all who are desirous of knowing the characteristics and the outlook of our South American neighbors. Mr. Elliott discusses social conditions at length; points out the remarkable fact, known to all who are thoroughly acquainted with the country, that the Brazilians have no such inherent tendency to revolution as is found in some of the Spanish-Americans, and hence that Brazil may be regarded as having a stable government under which industry may find protection; he gives an excellent account of transportation facilities, and of the dominant industries; discusses the currency, banking, and investments, the Federal, State, and municipal debts, and the sources of revenue. Other chapters deal with natural products, and commercial relations. He has caught the romance of the rubber industry, and he reveals the short-sightedness of the Government in its restrictive policy, crushing the rubber business under excessive export taxes, a blindness equalled only by that of the great rubber merchants who took no steps to develop the planting of orchards to insure a continuance of the output at a time when they might have succeeded. Instead of such a wise forward vision, they remained content to make their brokers' commissions on the dwindling supply, and laughed at those who proposed to rationalize the industry, while the problems of cultivation of the rubber tree (Hevea brasiliensis) were in the meantime being worked out in Ceylon, leaving the Amazon valley finally in nearly the same position with regard to this natural product that the scientific culture of cinchona in Java left improvident Peru. Mr. Elliott has taken only a glancing shot at the mineral resources of Brazil. He barely mentions the St. John del Rey, the deepest gold mine in the world, and one would never guess from his account that the State of Minas Gerães has the largest untouched deposits of bessemer iron ores in the world, nor that the United States is more dependent upon the manganese mines of the same remarkable State than we like to admit; but the emphasis of the book, nevertheless, is laid on the agricultural riches of the country, where it properly belongs in view of their preponderance. It must be remembered, however, that immense areas of Brazil are so covered with jungle and with deep soils, that the mineral possibilities are at best but imperfectly known, and that geologists such as Orville A. Derby and Dr. John C. Branner have given reasons for belief in the ultimate development of such resources on an important scale.

TUBE MILLING. A Treatise on the Practical Application of the Tube Mill to Metallurgical Problems. By Algernon Del Mar. Pp. 159. Ill., index. McGraw-Hill Book Co., New York, 1917. For sale by MINING AND SCIENTIFIC PRESS. Price, $2.

This enjoys the distinction of being the first work on tube-milling ever written. It is prepared by an engineef of wide practical experience in milling, who has acquired his knowledge by personal application in obtaining economic results, supplemented by wide and appreciative study of the multitudinous contributions on the subject in technical periodicals and in the bulletins of engineering societies. It brings together significant data drawn from the experience of metallurgists all over the world, discussed by a discriminating critic in the light of his own work. It is a handbook of details, presented in orderly manner, that must prove useful to designers of new plants and to engineers in working out their efficiency-problems. Mr. Del Mar is fully aware of the present limitations of ball-mills and tube-mills, and he states that "every variation of shape and every means of screening to attain capacity with the least expenditure of power" is being investigated by mechanical and metallurgical engineers. The tonnage per horse-power in tube-milling varies from 1 to 2.5, and the latter figure is far above the average. Variations in the character of ore, size of material fed, fineness of crushing, and many other factors, enter into this result, yet it is evident that the output is not great in comparison with the power required. In general it may be said that under what may be regarded as average conditions as to character of ore, and cost of power and supplies, the cost per ton when grinding to about 100-mesh is above 30 cents. In exceptional cases it is reported as low as 10c., and Mr. Del Mar discusses an unusual case at the Gold Hunter mill in Idaho where a feed with 94% of plus 35-mesh material was ground to a discharge containing 30% of minus 200-mesh pulp at a cost of 7.3c per ton, this including consumption of pebbles and lining, repairs, and power. Improvements in tube-milling that would reduce the cost on

average hard ores to 20c. per ton or less would open up enormous possibilities in the treatment of low-grade ores.

Mr. Del Mar describes in considerable detail all the well-known mills, the Abbé, Herman, Chalmers, Hardinge, Marcy, 'Compeb,' and Marathon, and he explains the special functions of the different types in grinding for concentration and for cyaniding, making comparisons illustrated by screen-analyses of the products. He also goes into detail concerning the factors that govern capacity, the heat generated in crushing, the relation of coarse to fine ore in giving capacity, and the influence of variation of feed upon efficiency, as well as the proper dilution of pulp to obtain the best economic results. The book gives abundant data regarding the El Oro, Globe, Osborne, Miami, Komata, Liberty Bell, and other liners; feeding and discharge devices; power requirements; details of mounting, foundations, and other practical matters which are important in operation. One chapter is devoted to amalgamating in tube-mills, and another to grinding for flotation. It is an eminently useful and usable book, that will commend itself to engineers and mill operators.

TIMBER FRAMING. By Henry D. Dewell. Pp. 272, with index. Well illustrated. The Dewey Publishing Co., San Francisco. For sale by the MINING AND SCIENTIFIC PRESS. Price, $2.

Every mine manager and superintendent is interested in anything that has a practical bearing upon the business in which he is engaged. Frequently it is necessary to design and build surface-structures at mines. Ore-bins, mills, headframes, trestles, flumes, and variety of other structures are required from time to time, and when such occasion arises, it usually devolves upon the superintendent to prepare a design for the proposed building, or whatever it may be, that is wanted, particularly at the smaller mines where there are neither civil nor mechanical engineers on the staff. Then it is that a knowledge of how to go about the job becomes necessary. The kind of timber to employ for various purposes, the calculation of the stresses that will be set up in the structure when completed, and in use, and how properly to meet them by suitable design and joining of the several parts, these and other equally important questions have to be anticipated and provision made to meet them. In such an emergency this book will prove of great value. It is desirable that the structures be as simple in design as possible, while meeting the demand for safety and efficiency. There is a very common lack of the appreciation of the strength of timber-structures properly framed, and this usually results in much unnecessary expense and waste of materials by building a structure in which the timbers are of far greater size than the condition demands, and in employing numerous members where none at all are requireddm Fortunately, however, the novice in timber-structure design usually errs on the right side—he seldom builds a weak one. By knowing how, the designer builds neither too expensively, nor is his structure weak. It is in the determination of these questions that Mr. Dewell's book will be of value. He has had large experience in the design and building of structures consisting principally of wood, and a study of his methods, as described in 'Timber Framing,' cannot fail to prove of great value to those lacking practical experience in this particular line of work, but which can be readily acquired by a study of this instructive book.

The chapters on working-stresses, washers and pine, joints, trusses, columns, and splices are particularly good; also that on foundations. Some space is given to the design and construction of head-frames, flumes, and ore-bins. The last chapter is devoted to specifications for timber framing, which appears to be complete. The book has been prepared with care, not so much for the engineer experienced along these lines, but rather for the practical man who desires also to know. It is a book that will undoubtedly meet with a large demand.

Mining Decisions

GRUBSTAKE CONTRACT—THIRD PARTY INTERESTS

Where a prospector grubstaked by plaintiff was accompanied on a prospecting trip by a second prospector who was grubstaked by his mother, and who had agreed to share with the first prospector any locations made under the grubstake contract with plaintiff, the mere fact that the first prospector assisted the second in making certain locations in the name of the latter and his mother would not entitle plaintiff, who had no contract with the second prospector, to claim any rights in such locations.

Turner *v.* Wells (California), 238 Federal, 766. February 13, 1917.

TUNNEL EASEMENT—DUMPING PRIVILEGES

Defendant acquired by right of way deed the right to use a tunnel in plaintiff's mine and to extend the same into his own claim. In an action to recover damages for his dumping of waste rock upon the surface of plaintiff's claim, it was held that the deed did not by implication give defendant such rights unless he could not without unreasonable inconvenience and expense, obtain dumping privileges elsewhere in the operation of the tunnel.

Himrod *v.* Ft. Pitt Mining & Milling Co. (Colorado), 238 Federal, 746. January 26, 1917.

TUNNEL EASEMENT—EXTINGUISHED BY PRESCRIPTION

Where plaintiff's predecessors in interest in early days acquired an easement for a mining tunnel through property owned by predecessors in interest of defendant and thereafter suffered defendant's predecessors and defendant to use the tunnel as a water tunnel for more than 20 years, openly, notoriously, and continuously, the easement was extinguished by prescription, irrespective of the means by which it was originally acquired.

Wall *v.* United States Mining Co. (Utah), 239 Federal, 90. December 1, 1916.

OIL LEASE—LESSEE'S OBLIGATIONS

When the lessee of a tract of land for the production of oil and gas has paid an adequate consideration in cash and has complied with the only obligation expressly required of him during the first year after the signing of the contract, by the drilling of one test well, and has not found oil or gas in paying quantities, the grantor is not entitled to a cancellation of the lease on the ground that the lessee failed to perform an implied obligation to drill more than one well for the common advantage of the lessor and lessee.

Nabors *v.* Producers' Oil Co. (Louisiana), 74 Southern, 527. March 12, 1917.

STATE LANDS—MINERAL LOCATION OF IN OREGON

A person locating as mineral land school land owned by the State of Oregon acquires only a temporary possessory right, subject to divestment by failure to purchase or lease the lands as required by the State law from the State land board. Where plaintiff assisted defendant in entering and leasing a mining claim actually within his own staked claim, and later, when defendant struck pay ore, admitted in the presence of witnesses that the claim belonged to defendant and offered to buy it, plaintiff was estopped from claiming the property as his own. An interest in a mining claim must be created in writing and cannot be created by verbal option.

Grand Prize Hydraulic Mines *v.* Boswell (Oregon) 162 Pacific, 1063. February 6, 1917.

INDUSTRIAL PROGRESS

Mining Manganese in Virginia

In the early '80s, Virginia produced practically all the manganese then mined and necessary for the maintenance of the steel industry in the United States. Not only did she produce sufficient for steel requirements, but for all other purposes in which manganese is used. All of this ore came from one mine, that of Crimora, in Augusta county.

The quality of the Virginia ore compares favorably with that recovered from the mines of Russia, India, and Brazil, providing care is taken in the grading of the ore. The quantity of the ore available is very large. It is impossible to even guess at the tonnage, for the reason that nearly all of the deposits, particularly in the Blue Ridge district, are embedded in clay, the enrichment area of which is irregular.

After the Crimora mine had been in operation a few years, work was suspended on account of litigation, but recently the property was purchased and reorganized by a new company and is now operating under a charter granted to the Crimora Manganese Corporation. The mines and plant are at Crimora, Virginia.

The holdings of this company consist of about 1200 acres, but not all of it is manganese-bearing. The manganese area is confined to a basin lying between the foothills and the main Blue Ridge mountains.

The first thing undertaken by the new management was to arrive at some definite conclusion relative to the tonnage that still was in place within the basin. A number of Keystone drills were set to work and drilling started. Up to the present time perhaps 100 drill-holes have been put down to the Potsdam beds, giving the thickness of the ore-bearing clays ranging from 150 to 275 ft. This drilling has enabled the management to arrive at an approximately safe estimate of the ore reserve which is calculated at from 7,000,000 to 9,000,000 tons.

A VIEW OF THE EXCAVATOR AND GRAVITY RAILROAD

THE EXCAVATOR BUCKET AT WORK

THE MILL

The next step was to provide new equipment for both the mine and mill.

At the pit there has been installed a drag-line excavator with a 1½-cu. yd. bucket of the 'Scofield-Burkett' type. This excavator has a capacity of 125 tons of material per hour. This bucket dumps the material into a large revolving-pit, having a capacity of 50 tons.

From this pit the material is transported to the washer by means of an incline gravity-railway, operated by 2250 ft. of 1-in. Leschen wire rope; two 4-cu. yd. side-dump cars being

used. From these cars it is dumped into the main storage-bin at the top of the mill.

The mill has a capacity for treating 1000 tons of material per 10 hours. The plant, as designed, can handle over 100 tons of washed ore daily.

A reservoir has been provided in the mountains, having a storage capacity of 27,000,000 gal. of water. The water from this reservoir is conducted to the mill through a 6000-ft. flume under a 140-ft. head. In addition, another reservoir is now under construction, with a capacity for impounding 17,000,000 gallons of water. The mill, as designed and when operating at full capacity, requires about 1,000,000 gal. of water per day, which, if no recovery of water were made, would insure maximum operations for nearly two months; this would extend through the most prolonged period of drought ever experienced in that region.

In addition to the 1-in. Leschen haulage rope already mentioned, this company is also using Hercules red-strand wire rope as a part of its wire-rope equipment. Other makes of wire-rope are also used. The illustrations have not been selected with the particular purpose of showing Leschen wire-rope in use, but to show the working of a plant that is especially interesting at this time.

Protection of Surfaces From Acids

Possibly the severest conditions to which paints are subjected are those in which surfaces must be protected from strong acids. Surfaces under these conditions have usually meant large up-keep expense. Many paints have been tried for this purpose, and it has been difficult to obtain a satisfactory paint. One of the largest chemical companies in the United States had tried 52 paints to February 1916, and the longest time that the best paint stood up under the severe conditions of a nitric-acid plant was 14 days. In February 1916, Oronite enamel paint was used and the original surfaces were not re-painted until February 1917, when the plant was given its annual overhauling. During that time the original paint had been unaffected by the severe acid conditions. There has now been purchased by this company upward of 6000 gallons of Oronite enamel paint for use under all acid conditions.

Commercial Paragraphs

The LINK-BELT CO. has issued an interesting and instructive bulletin descriptive of traveling water-screen for condenser-intakes, the object of which is to remove from the water any foreign matter that can be collected on a screen, and thus prevent it from entering the condenser. This can best be accomplished by a screen that clears itself automatically of the accumulated débris. This company has also issued Data-Book No. 125, being an illustrated description of the silent chain-drives, for many purposes. It is an interesting book and contains much that is of practical value to those whose requirements demand the transmission of power.

The DUPONT POWDER CO. has issued a very readable and useful book on 'Blasting Supplies,' as Bulletin A-481. It treats of the numerous accessories necessary in blasting-operations, including blasting-machines, electric blasting-caps, delay electric-igniters, delay electric blasting-caps, safety-first thawing-kettles, blasting-mats, and various other things used in rock-blasting. It is a book that will interest every mining superintendent.

This company has introduced a new preservative paint, under the trade name Carpo, intended for the protection of all wood and metal surfaces that are exposed to the action of the air or water. A complete description of this new compound can be had on application to the E. I. du Pont de Nemours & Co., Equitable building, New York.

New Type of Outdoor Lighting-Unit

A common type of street lighting-unit is illustrated at the right in Fig. 1. A large part of the rays are thrown upward

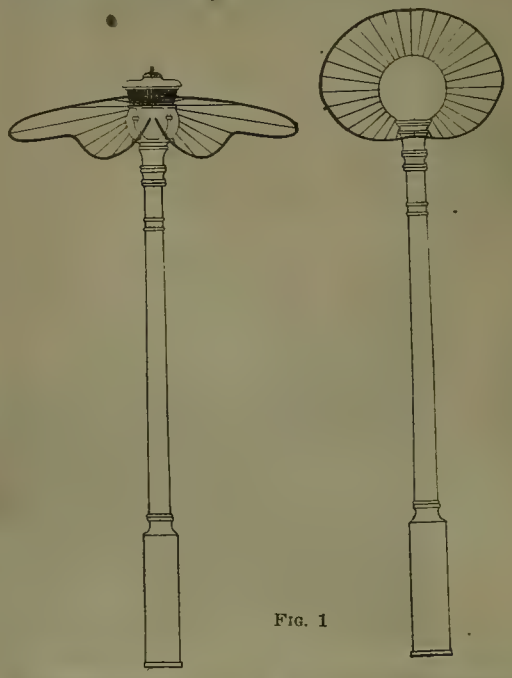


FIG. 1

FIG. 2

and lost. The General Electric Co. has recently perfected a lighting-unit illustrated at the left in Fig. 1, where the rays are reflected downward, where they will do the most good. The same kind of unit, but of the pendant type is shown in Fig. 2. This kind of lighting unit is suitable for lighting streets, and also large open spaces such as docks, lumber and railroad yards, platforms at railroad stations, and yards of industrial plants.

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AN INDEPENDENT PAPER OWNED, EDITED, AND MANAGED BY ENGINEERS

THE FLOTATION PROCESS

All patent and other rights to this process in North America are now controlled by

MINERALS SEPARATION NORTH AMERICAN CORPORATION

On December 11, 1916, the SUPREME COURT OF THE UNITED STATES adjudged our basic patent for **air-froth flotation** to be valid, holding that this patent covers any process of froth flotation wherein the **results obtained** are secured by the use of a fraction of one percent., on the ore, of an oily frothing agent in an ore-pulp, with agitation. Three of the thirteen claims which specified the use of "**a small quantity of oil**" and which the Court held to be invalid have since, by proper disclaimer, been brought within the scope of the Supreme Court's decision and, at a recent trial in the United States District Court at Butte, Montana, Judge Bourquin admitted these claims as amended.

On May 24, 1917, the UNITED STATES CIRCUIT COURT OF APPEALS at Philadelphia, in the case of Minerals Separation, Ltd., against Miami Copper Company, unanimously sustained the validity and broadly construed **a second basic patent,** owned by us, for the use of **all "Soluble Frothing Agents."** In the same opinion, the Court also validated a third patent for the use of cresols and phenols in the cold and without acid. The defendants, Miami Copper Company endeavored to avoid infringement of these patents by using Callow pneumatic cells, but the Court held that the operations of the defendant company infringed all three patents.

Prospective users of our flotation processes are earnestly requested not to be misled by the mistaken views disseminated by interested parties that any of these BASIC PROCESS PATENTS can be evaded by a mere variation of apparatus for agitating and aerating the pulp, or by the simple addition of oils or other materials in excess of a fraction of one percent. on the weight of the ore treated.

NOTICE

Notice is hereby given that we will enforce our patents and stop all infringements, but are prepared to grant licenses for the right to use all or any of our processes to those who wish to use them.

To those who infringe or have infringed our patents, notice is given that A SETTLEMENT FOR SUCH INFRINGEMENT MUST PRECEDE THE GRANTING OF LICENSES FOR THE FUTURE USE OF SAME.

Notice is further given that no one is authorized to introduce our processes or apparatus into the United States, Canada, or Mexico.

All applications should be made direct to

MINERALS SEPARATION NORTH AMERICAN CORPORATION

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61 Broadway
New York, N. Y.

Engineering Office
Merchants Exchange Building
San Francisco, California

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Antimony Deposits of Arkansas

OLIVER FILTERS

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Borax	Ink Dyes	Sodium Bicarbonate
Calcium Carbonate ppd—	Iron Concentrate	Sewage
Calcium Carbide	Kelp	Sugar
Calcium Sulphate	Lithophone	Tailings
Caustic Mud	Lamp Black	Talc
Cement Slurry	Lead Concentrate	Ulexite
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E. H. LESLIE
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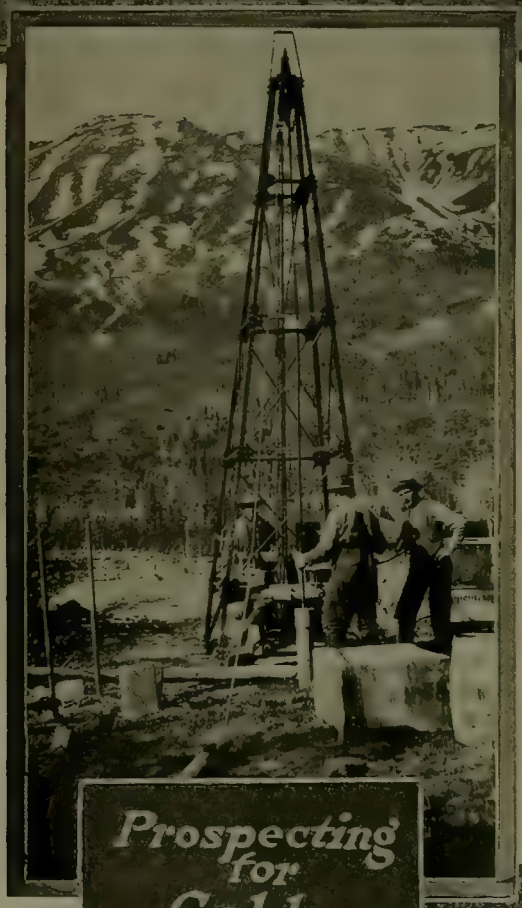

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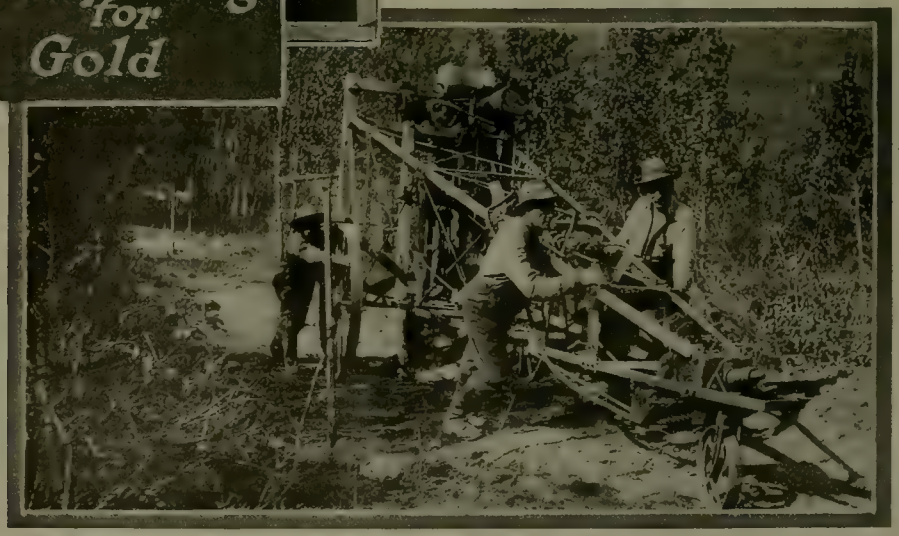


EDITORIAL

T. A. RICKARD, Editor

ALUMNI of the Colorado School of Mines will be sorry to learn that Mr. H. C. Parmelee has been compelled to resign his position as President of the School, on the vote of the three trustees that are not alumni. Our opinion of the fitness of those trustees for their duties was expressed in these columns two weeks ago.

FOUR million persons subscribed three billion dollars toward the Liberty Loan. Among them the country owes a hearty vote of thanks to the bankers, who not only contributed of their funds but also gave services of a most useful kind to the work of collecting subscriptions. Our moneyed people are behaving very well in these great days.

MINING is playing its part in the War, as everybody knows by this time. We received a letter the other day from the Assistant Inspector of Mines, not at Butte or at Bendigo, but 'somewhere in Flanders'. The object of this mining was not so many ounces of gold or pounds of copper per ton but so many of the enemy per cubic yard of blasted ground. The gallant Major that occupies the responsible position just mentioned is well known to students of the peaceful art of mining, from Johannesburg to New York. His useful work at Messines was accomplished by the use of that new explosive, ammonal, in the manufacture of which a metallurgical neighbor of ours had won frequent publicity.

AMONG recent patents for methods of flotation we note No. 1,228,184, of May 29, 1917, issued to Mr. Henry P. Corliss, the joint author of the excellent article appearing in our issue of June 2. Mr. Corliss is not tied to Minerals Separation; he has assigned his patent to the Metals Recovery Company, of New York, with which Mr. W. B. Thompson is identified. He uses nitro-naphthalene, either alone or with oil, as his frothing agent. This substance is non-oleaginous and solid, but can be dispersed in the pulp so uniformly as to perform its frothing function most efficiently. Only a quarter of a pound of it need be used. The nitro-naphthalene is recoverable from the froth and can be re-used for the treatment of fresh ore. Remarkable results have been obtained with the use of this substance in the Magma mill, in Arizona.

OUR CORRESPONDENT at Cobalt, Ontario, tells this week that an order in council has been passed by the Provincial government relieving the holders of mining claims from the performance of assessment-work for the year 1917. The order is not for absolute exemption, but grants a year's extension of time within which to do the statutory work. It might be well for us to take note of the thoughtful consideration extended by Ontario to its miners, and to follow suit in some appropriate manner. At the prevailing extravagant cost of supplies the required $100 worth of work would not make much of an impression in effective development this year in any event. It has been suggested that enlisted men, at least, should be exempt, which appears to be no more than common justice. We venture to add that when the next call for subscription to government bonds is made in September, the law might provide for accepting the purchase of a bond in lieu of the annual assessment work, but without counting it in the total of the $500 worth of work demanded as an antecedent requisite for the obtaining of patent.

EMULSIONS are of supreme significance to the flotation metallurgist, now that the colloidal dispersion of oil in mill-pulp, and its subsequent breaking so as to oil the bubbles, has become a 'critical' question in the great litigation between the patent and the art. Every contribution to our knowledge of the subject therefore is welcome, and the article on 'Physical Chemistry of Emulsions' appearing on another page of this issue will prove of great interest, coming as it does with the authority of such a distinguished scientist as Dr. Martin H. Fischer. His insistence upon the importance of using all the water in the formation of a colloid hydration compound in preparing a 'permanent' emulsion throws light on the function of the contaminant in flotation, especially as related to the equally necessary condition of breaking the emulsion in supplying oil when needed for oiling the bubble-film and the mineral-particle. Dr. Fischer's reference to the characteristics of casein, with either acid or alkali, as a stabilizer of oil-emulsions, and the conditions under which such an emulsion breaks, is also suggestive.

IT WAS Dr. Raymond, we believe, who first said that we might ask 'Who's Who'? but not 'Who's Hoover'? Assuredly we mining engineers need ask no such question, and yet, in a deeper sense, a great many that know Mr. Hoover only slightly must have asked themselves now that he has become so famous just what kind of man he really is. To them we commend Mr. Will Irwin's article in the current issue of the *Saturday Evening Post*. Mr. Irwin's appreciation is called 'The Autocrat of the Dinner Table', and it is well done. They were at Stanford together and the trails of the reporter and story-writer have crossed those of the engineer and financier so often during recent years that the one is well able to

do justice to the other. Something to criticize of course there is—such as the "new processes" that the young American introduced in Australia and the repeated reference to the head-hunters of Borneo, meant probably for the development of the Bawdwin mines in Burma—but we refer to these slips only to emphasize our own knowledge of Mr. Hoover's mining career and then to second most cordially the stress laid by Mr. Irwin on the dominant note in Mr. Hoover's character: sincerity. It is the sincerity of his purpose that has enabled him to over-ride opposition in the highest quarters when engaged in his great Belgian benefaction, and to the same fundamental quality he will owe his success in overcoming such opposition as he is now facing before Congress. This sincerity of purpose is another phase of the intellectual honesty that made him so efficient as an engineer and so successful as an organizer of big enterprises. And through the complex fabric of his personality there run golden threads—nay ribbons—of generosity. Long before the children of Belgium learned to associate his name with charity or the refugees from his own country found assistance at his hands, he had given expression to his innate kindliness by assisting those in distress, often the less fortunate members of his own profession. His sympathy with suffering was no trait developed on the approach of German brutality; long before the War it was a winning weakness of which his personal friends were well aware. So also his large interest in public affairs and his intensely patriotic interest in American affairs. He has been in our mind when in recent years we have spoken of engineers that found time to be good citizens and of metallurgists that could spare time to broaden their culture. But we must stop. Read Will Irwin's story.

Control of Coal and Transportation

There has been oppressive silence in the newspapers regarding the recent radical recommendation of the Federal Trade Commission to Congress, proposing that the United States Government should take possession of the sources of coal and coke in the United States, and operate them through a Government agency, and also that the transportation systems of the country, both rail and water, should be "similarly pooled and operated on Government account, under the President, all such means of transportation to be operated as a unit, the owning corporation being paid a just and fair compensation, which would cover their normal profit, upkeep, and betterments." The first news was 'featured' in the evening papers, but it occupied an inconspicuous position in the morning papers the day after, and the matter has since been carefully shielded from the public gaze. A few remarks have been made to the effect that this tended toward communism, and that it should be branded as socialistic, which we admit would be a reproach. We believe that Socialism means, in the last analysis, the denial of individual initiative, but we do not see that the Government administration of the transport systems involves a denial of the individual initiative; therefore we would not call it socialistic. We believe that the Socialists have developed some good ideas, which should be utilized without regard to their parentage for the betterment of government, but this is very far from accepting a socialistic programme, which at bottom, we believe would tend toward intellectual stagnation and prove injurious to organized society. It is well to recognize that the railroads are so vital in our social system, and are so necessarily subject to Federal supervision in order to ensure just and equitable treatment, that they have always possessed chartered prerogatives of eminent domain that partake of the nature of sovereign powers. There was a time when men had to send their letters by special courier, or pay private individuals and associations of individuals for transporting them. It would seem absurd in these days to undertake to manage a nation's correspondence in any such bungling manner. There was also a time, not long past, when it was the custom to grant franchises to private corporations for building highways, including the right to collect toll. We know what people would think in these days of turning over the highways to private toll-collecting corporations. The report of the Federal Trade Commission indicates that it has been discovered that the coal mines are involved to an intolerable extent in inefficient methods of production and that the railroads are inadequately equipped for transportation and scientific distribution of products, and furthermore that, locked up in the system as it now stands, there exists the evil of unbridled speculation detrimental to the public welfare at all times, and imperilling the nation in time of war. These charges have been frequently hurled at the railroads and the coal 'barons,' and they now meet with confirmation from a source of such character that it must be respected. Under Government control the railroads could be made to serve as a regulator of manufacturing operations and a balance-wheel of industry. When times are dull and prices correspondingly low the Government could avail itself of the opportunity to carry forward betterments and renewals of permanent way and rolling-stock, thus tending at the same time to improve financial conditions. When business was active the railroads, under such intelligent direction, would not be under the necessity of intensifying the upward trend of prices by coming forward with large orders for equipment in order to meet the demands of an increasing traffic. Today the railroads are practically in the hands of the Government through the regulation of rates and other control of operations as exerted by the Inter-State Commerce Commission. The Congress has regulated wages, and the workmen themselves practically determine the time-tables and length of run by train-crews. Unification of management would reduce enormously the overhead cost, by obviating the existing duplication of officials, agencies, and terminals. Solicitation of business, another costly item, would disappear; and restriction upon the use of cars beyond single railroads would be avoided. Expropriation would be unnecessary

to carry into effect a complete scheme of nationalization. The Government's guarantee of interest on outstanding bonds and of normal dividends on stock would strengthen the position of all such securities in the market, and fully satisfy the rights of ownership, since the value of ownership as a source of income would be conserved; it is merely the opportunity for flamboyant financing through control of proxies that would be eliminated. The interests of the real owners, the stockholding public, would be protected not alone in the certainty of dividends, but in exemption from the perils of speculative manipulators. Instead of conceding the addition of 15% extra to existing freight-rates it might be well to relieve the distressed officials from further worry by letting the Government struggle with the problem.

The Miami Appeal—II

In our last issue we summarized the two opinions of the Court of Appeals at Philadelphia. More remains to be said. The majority opinion includes sundry references to the technology of the process that call for respectful demur. Judge Woolley, for example, says that the patent is based upon "a discovery that the affinity of oil for metal is greatest and the metal recovery highest when the proportion of oil to ore is relatively least." Can the "affinity" of oil for metal vary? Physical forces are constant. Is not the use of oil proportioned to the 'mineral' in the ore, not to the 'ore,' which includes both gangue and mineral? It is unfortunate that the Court should have been misled into publishing a statement that the recovery is highest when the proportion of oil is least at a time when several plants, working on a scale of 1000 tons per day, or more, and using a maximum proportion, over 1%, of oil, have obtained results as good, or in some instances better, than those obtained with a fraction of 1%. Judge Woolley states that before froth-flotation was discovered there were only two processes that had "reached the commercial stage"; he mentions the Cattermole and the Elmore bulk-oil methods, ignoring the fact that Elmore's vacuum method, using air as a flotative agent, was far more widely used, and more nearly a "commercial" success, than either the Cattermole granulation or the older bulk-oil process. He describes Froment's method as one dependent upon a thorough oiling of the mineral and using agitation "for the sole purpose of causing the metal particles to rise", although, if we remember correctly, Froment, in his patent, laid emphasis on the formation of a gas for the production of bubbles, rising to the surface, "where they form a kind of metallic magma", or a mat of mineral-coated froth. Referring to 'the' discovery, namely that supposed to have taken place in the Minerals Separation laboratory in March 1905, the learned Judge says that "its great value, especially in zinc and copper ore concentration, met with world-wide recognition. The art immediately adopted it and paid tribute to it." If we are correctly informed, the first attempt to use froth-flotation was not made in the United States until 1911—six years after patent 835,120 had been granted—and the first plant designed under the supervision of Minerals Separation in the United States was built in 1913—eight years after the supposedly epochal event.

In regard to the so-called 'critical' proportion of oil: the idea of such a point was prompted probably by the imperfect emulsification of the oil, the excess of unemulsified oil in the pulp being a deterrent to successful frothing. There is a true critical proportion of oil that can be permanently emulsified in water, and Mr. William C. McC. Lewis has determined this to be approximately 2% in the case of mineral-oils. As our readers are aware, several of the large copper-concentrating mills have been using 22 or 23 pounds—more than 1%—of oil successfully, obtaining even higher recoveries than when using small fractions of 1%. But the use of the larger proportion is wasteful, therefore only 10 pounds of oil per ton is being employed now, because that suffices to avoid conflict with the claims made by the Minerals Separation people, whose counsel, before the Supreme Court, stated that the supposed beneficial effect of using less oil began when the proportion was under 0.5%. Apparently, therefore, the use of this proportion of oil in a pneumatic cell would comply with judicial requirements. By the way, sundry licensees of Minerals Separation are using the pneumatic type of flotation machine; if the Philadelphian decision is made good it would appear as if they would have to settle with the owners of the Towne and Callow patents, covering the use of porous media for aeration. For some ores the violent agitation of the Minerals Separation blade-impeller machine is best, for others the quiet aeration of the Callow cell, and for others again it is found advantageous to supplement one method for another when re-cleaning the concentrate. That brings us to the preliminary mingling of the oil in the pulp previous to admission into the froth-making machine. Apparently it will be necessary to comply with the Philadelphian decision by using some such method as appears in 'the prior art'. Will a bucket-elevator come within the prescribed limit? Minerals Separation has patented the Chapman idea of oiling the pulp in a grinding-mill. We are informed, however, that the use of modifying agents in a tube-mill is not new because it was disclosed in a patent for crushing guayule issued to H. T. G. Vanderlind, No. 979,902, in 1910, whereas that of G. A. Chapman is No. 1,102,874 of 1914. It is unlikely that the Courts can be induced to decide that all kinds of mixing or stirring constitute an infringing agitation, in view of the terms of patent 835,120, in which one kind of agitation is so carefully specified. We suggest that, since the point of public interest is to introduce emulsified oil into the pulp without previous violent agitation, this emulsification of the oil in water can be accomplished in vacuum as well as in the atmosphere, and may be attained also by other means.

In the meantime there is that "soluble frothing-agent" of patent No. 962,678, which has been sustained at Philadelphia. This one also is tied, like No. 835,120, to a violent and persistent type of agitation. Therefore it

would seem that mill-men would be free to use either a soluble or a non-soluble agent in a pneumatic cell. Meanwhile the various laboratories have ascertained that the presence of a soluble frothing agent is not essential to flotation. Pine-oil, when pure, is insoluble and the pure varieties of the creosote series are likewise insoluble, although the commercial varieties of these products are not pure and cannot be made pure within reasonable limits of price. The patentees apparently had in mind such agents as were in major proportion actually soluble in water and they should not be able to prevent the use of agents that contain only a relatively small quantity of soluble fractions of an accidental nature, because in the fractional distillations it is impracticable to make any particular fraction pure without going to prohibitive cost. Incidentally, we may refer to the curious remark made by Judge Woolley in regard to inorganic frothing agents. He suggested that two of the claims of patent 962,678 "cover inorganic frothing agents also," although he said that he knew of no such agent. Would it be respectful to describe this remark as supererogatory? Are all oils of organic origin? What is an oil? Perhaps the learned Judge or one of his colleagues in another court will have the privilege of answering this conundrum also.

Price Regulation

Two wholly distinct ideas are before the public relative to commodity-costs. The result is confusion. There is talk of price-control; there is also talk of profit-limitation, of the sort that is seen on contracts proposed and completed for ships and arms and motors and a host of other equipment that the Government is to obtain at cost plus 10%. The public has been vaguely under the impression that 'cost plus 10%' involved cost-control. It does nothing of the kind. The cost may be anything at all; under such a contract it makes no difference to the manufacturer how high the market-value of raw material may mount; or, looking at it from another angle, which no intelligent manufacturer could be expected to ignore, the higher the cost the larger the commission, by applyng the simple rule of 10%. The question of real interest to the public is the limitation of costs; limitation for the sake of every consumer whether he be a humble workman earning $2.50 per day, or Uncle Sam borrowing $2,000,000,000 to spend again in the purchase of munitions. It has been said that high costs mean circulation of more money, therefore re-duplication of profits, and again, in natural sequence, widely distributed gains. This has the doubtful merit of all half-truths. It applies to one class of mankind, namely, to the man who produces or manufactures or sells for his own account. The hireling, save in a few cases where an equitable sliding-scale governs his pay, is the one that bears the larger burden of the extra cost. Since the fundamentals of human necessity are food and shelter, and since the more insistent of these is food, the cry for food-control that has stirred Congress is understandable, but Congress has muddled into the solution of the problem *animo non astucia*. This blindness to the larger issue is the legitimate result of distress caused by the unconscionable increase in food-prices. The increase since last October, expressed in percentages, is shown by a table printed in the Congressional Record on May 12, from which we take a few items. Oatmeal has advanced 33%, navy beans 111%, split peas 71%, chuck roast 46%, ham 29%, potatoes 138%, and onions 186%. Meanwhile, to view another aspect of the case, the profits of the American Can Co. in 1916 were approximately 200% above those realized in 1914; of the Bethlehem Steel Company 680%; of the Crucible Steel Company 1200%; Phelps-Dodge Corporation 230%; the American Smelting & Refining Company 150%; and the net revenue of the railroads of the United States had risen from $275 per mile in 1913 to $550 per mile by October 1916, since which time there have been further advances.

The great issue, to obscure or neglect which is to trifle with the needs of the Government and of the people in our preparation for war, is to regulate prices, not merely food prices but metal prices, and prices of every other commodity. It may not be strictly democratic to deny a man liberty to do what he will with his own and to ask what price he please for the product he may have to offer; but back of that lies the true spirit of democracy, which is equal treatment for all citizens. All men must be dealt with alike; no discrimination must be tolerated; no class legislation can rest upon the statute-books. That is so cardinal a constitutional principle that it is surprising to witness so little constructive criticism in Washington upon the various food-control bills that have been introduced. A few weeks ago when metal-price regulation was in the air the metal-producers held out as their chief argument in opposition the merry disturbance that would follow an attempt to govern the prices of foods, which they insisted would be involved along with metals in an attempt at price-control. They were perfectly correct in their view of the equal rights of all producers to be treated alike. We believe that the country is wasting precious time by not facing the whole problem of regulating commodities. One part is no more complex than another, and the laws must be just or they will provoke friction and delay; they must be constitutional or they will soon be reversed by the highest tribunal, suddenly throwing commercial relations out of adjustment, with consequent economic consternation. With bessemer pig-iron selling at $53 per ton it is clear that regulation of the steel and iron trade would be a public good; with copper selling to the Government at 25 cents and costs of production standing at about 12 cents, it is plain that some beneficial adjustment might be made; with lead selling at 12 cents and carried on the producers' books at 3.88 cents, it cannot be urged that potatoes are high-priced. As the metal-producers remarked, "if you regulate metals you must also regulate foods," and that is a good text for a wholesome democratic homily. While we are fighting for democracy let us not fail to keep our own democratic national platform from collapse.

DISCUSSION

Our readers are invited to use this department for the discussion of technical and other matters pertaining to mining and metallurgy. The Editor welcomes expressions of views contrary to his own, believing that careful criticism is more valuable than casual compliment.

Nitrogen in Metal Mines

The Editor:

Sir—My letter that appeared in your issue of May 26 on the occurrence of nitrogen in a bore hole on Pender island, Strait of Georgia, B. C., in which I suggested that some light about the nature of the formation might be thrown by Mr. Robert A. A. Johnston, author of 'A List of Canadian Mineral Occurrences,' has brought me a letter from that gentleman, in which he informs me that the occurrence was reported to him by Mr. William Fleet Robertson, and that he was writing to him requesting that he communicate with either your or me on the subject. Mr. Robertson chose the latter course, and I enclose his letter.

F. H. Mason.

San Diego, June 13.

[Mr. Johnston says that "gas of this kind might become useful in the manufacture of synthetic ammonia," but Mr. Robertson is of the opinion that the idea "does not appear to be commercial." He corroborates the analysis of the gas.—Editor.

Cost of Cyanide

The Editor:

Sir—Referring to a recent comment on the price of cyanide in Canada made by the Cassel Cyanide Company through arrangement with the British government, it is not correct to assume that all of the cyanide used in the mines of Ontario is supplied f.o.b. Ontario points for 15 cents per pound.

On the 21st of October, 1914, the Cassel Cyanide Company offered a three-year contract to the mines of Northern Ontario as follows: "Entire consumption of cyanide at the company mines until December 31, 1917, beginning January 1, 1915, delivery, c.i.f. South Porcupine, Ontario, ocean war-risk for buyer's account, price 18c., basis 100% for high-grade sodium cyanide, until June 30, 1915; to the end of 1916, 16c., to the end of 1917, 15c. If buyers prefer 98 to 100% cyanide, sellers will endeavor to deliver this quality, the price of the same to be 1c. per pound more."

Then followed an estimated quantity which would be consumed by the mine during this period. As the price mentioned in the contract covers cost, insurance, and freight, but not ocean war-risk nor duty, there is approximately 1c. per pound to be added to the above figures.

Some of the mines exceeded the estimated consumption to a considerable amount and have been obliged to make new arrangements for their current requirements. Others did not enter into the contract and have been obliged to purchase their cyanide under current quotations from the Cassel Company. During the month of May, 1917, the net price of sodium cyanide, so-called 129% grade, landed at South Porcupine, was 33.7c. This is probably the price at which all cyanide will be sold in Ontario after December 31, 1917, unless existing conditions should materially change in the meantime.

C. D. Kaeding.

New York, June 14.

Mines in Granite

The Editor:

Sir—Would you kindly answer in your paper the following question: Is there any truth in the often expressed opinion that metalliferous veins in granite are not persistent in depth or strike? Also are there any deep large mines wholly within granitic rocks?

Chas S. Boone.

San Francisco, May 29.

[Granite is considered by many as an unfavorable rock in which to look for permanent mines. That there is no sufficient warrant for this prejudice is shown by the fact that many profitable mines of gold, silver, and copper occur in granite. The Granite Mountain mine at Philipsburg, Montana, is in granite. It produced $25,000,000 yielding a large profit. The great copper mines of the Butte district, Montana, are in grano-diorite (a variety of granite), and these mines have paid hundreds of millions in dividends. The Empire mine, and all of the lower part of the North Star mines at Grass Valley, California, are in granite, and are both deep and profitable. The Black Oak mine in Tuolumne county, California, is over 1800 ft. deep, wholly in granite, and also profitable. The Soulsby and Confidence mines, likewise in Tuolumne county, are entirely in granite and have profitably produced precious metals to the extent of $6,000,000 and $5,000,000 respectively. Many more examples might be given. The prejudice to which our correspondent refers is the result of multitudes of failures that have attended the development of gold-bearing and copper-bearing pegmatite dikes and dikes of pegmatitic quartz, which are common in granitic areas. Pegmatitic quartz-dikes are almost universally mineralized to a small extent, that is, they contain sulphides and rare metallic oxides, and usually some gold, that crystallized out of the final silicious residual liquor upon the consolidation of the granitic magma. The mineralization in such cases is seldom uniformly disseminated; the tendency is toward isolated patches of enriched rock, with lean masses between. In many cases, however, such original dikes formed weak zones along which faulting

occurred later, followed by mineralization through the agency of ascending hot solutions sometimes forming valuable veins. Therefore it must not be inferred that the existence of pegmatitic quartz is in itself unfavorable. It is a question of the interpretation of the geologic history of the special deposit.—EDITOR.]

Sampling Large Low-Grade Orebodies

The Editor:

Sir—There has been nothing in recent years in the mining world that has attracted as much attention as the testing, development, and promotion of the Alaska Gold Co., and the results obtained when working upon a basis of 12,000 tons daily; the best engineering talent was brought to bear upon the problem before the property was offered to the public, yet the resulting recovery of valuable mineral failed to equal the estimate made. Cost estimates and flow-sheet were correct, showing that good judgment had been exercised in those fields. The failure, as we know, was due to faulty sampling, yet can one say, when over 300,000 tons of ore has been milled for a sample, that human foresight could offer a truer solution of the question of value per ton of the ore? The answer, it seems to me, lies in the possibility that this great tonnage must have been more or less selected. Was the entire ore-zone cut through and milled from wall to wall? Was it done in a number of places *as a test?* Was it not that certain stopes were started and mined for the mill-test? Those in charge know; I do not. Some years ago I was called upon to report upon a mine in south-western Colorado, claimed to have 5,000,000 tons of pay-ore, but which, after operating on a basis of 300 tons daily, failed to pay. The ore-zone was claimed to be from 50 to 60 ft. wide and 800 ft. long. Upon the main level, five cross-cuts were carried through the ore-zone from wall to wall. To determine the value per ton of the ore, I caused chip or moil sampling to be done in the foot-sections in each of the cross-cuts; following this, a power-drill was used to slab off a thickness of approximately 3 ft. of the ore, when the process of moil sampling was repeated on the freshly broken face. The ore from the 3-ft. cut, amounting to about 60 tons for each cross-cut, was sent to the mill, when it was crushed, sampled, and milled. The value of the ore was less than $3 per ton, but the three samplings, that is, the two moil-samples and the return from the mill, checked each other within 10c. per ton. It appears to me that under normal conditions of mining gold, silver, or lead-bearing veins, the foregoing method will come as close to a fair degree of accuracy as can be expected from mining operations. The sampling of orebodies never can be carried to absolute accuracy; at best it is an approximation, even where the most extreme caution is taken to prevent the human element influencing the final result.

To the young engineer engaged in sampling low-grade orebodies my advice is to sample by moil in pre-determined lengths, based upon the assumed value, and closely inspect the assay returns. When even a small variance from an accepted value for the orebody is found, re-sample that ground in smaller lengths, to determine the reason for that variance; then, with the fact clearly and well established that a portion of the orebody is richer than the rest, proper allowance and weight should be given to it, bearing in mind always that the ore broken in mining is sure to be lower in value than that broken by sampling. This simple fact has been so frequently stated in works on sampling that it seems out of place to state it again here, but it is a fact of vital importance in estimating the value of an orebody. Of course, if opportunity be given for test-milling, that should supplement the hand sampling, as there is no better known method of determining the saving than by subjecting properly selected parts of the orebody to mill work.

RICHARD A. PARKER.

Denver, Colorado, May 7.

The Editor:

Sir—My interest in your editorial on 'Sampling Large Low-Grade Orebodies,' and my convictions on the subject of moil-samples versus mill-tests, have prompted me to contribute to the further discussion of this interesting phase of mine sampling. I am a supporter of the moil-sample, and more than that, of the small-weight-per-foot moil-sample. I do not wish to decry the usefulness of mill-tests, nor of records of past yield, but I am convinced that in order to interpret the results of these with any reasonable degree of accuracy it is necessary that they be supplemented by moil-samples; or, perhaps, it would be better to say that it is of the greatest value to have moil-samples supplemented by mill-tests, since, if I have to depend on either method alone, I much prefer the moil-samples. I am assuming that a systematic method of sampling is employed and that the work is done by skilful men. In order to make my position clear, I should like to state a few basic principles that I believe underlie all successful estimation of standing ore by means of samples, whether these samples be mill-tests, slabs of ore broken by the aid of machine drills, heavy moil-samples averaging several pounds per foot, or light moil-samples (and this is the kind I believe in) averaging in the neighborhood of one and one-half pounds per foot. In the close of your editorial you touched so skilfully upon some of these principles that it is impossible to avoid enlarging upon the same topics, but I am rearranging them somewhat to place the emphasis rather more as it appears in my own mind, and I trust that the appearance of plagiarism will be forgiven.

The keynote of successful valuing of mines is interpretation, and this is based upon two factors: the judgment of the man doing the work, and the data on which he bases his conclusions. The first requires a natural aptitude for the work, plus sound training in the principles involved, and an experience that has seen those principles worked out. It is a mistake to assume that anyone that can cut a clean channel can sample a mine. The second requires the systematic collection and assem-

bling of reliable information. The best judgment in the world can be vitiated by deceptive data, and similarly the collection of reliable data is the first step in any process of mine valuation. There are two outstanding facts which must be evident concerning these data: they must be representative, and they must be accurate, detailed, and specific, so that when, at the end of his work, the examining engineer brings his judgment to bear upon them, he may have a full set of tools with which to work. Applying these criteria to mill-tests and moil-samples in turn:

(1) They must be representative. In this I think one may safely say that the moil-sample outclasses the mill-test. The mill-test, like the moil-sample, is representative only of that portion of the mine from which it comes, but, unlike the moil-sample, its bulk is so large that from sheer cumbersomeness it cannot be duplicated over many parts of the mine. The average of all the mill-tests made on the deposit is therefore more likely to be broadly selective, and the result in error by just that much, whereas the moil-sample can penetrate every nook and cranny of the available workings. This is the great danger inherent in mill-tests, and I believe the error due to this is far greater than that generally attributed to moil-samples from other causes, and rectified in them by a sampling factor.

(2) They must be accurate. This is where the advocates of the mill-test get in their big work. Admittedly, the small speck of accidental gold in a moil-sample weighing one and one-half pounds per foot has a tremendous effect, and also the mass of a mill-test will reduce such accidental variations to a minimum. As a single isolated result the mill-test will certainly show a tenor much more nearly like that of the mine. The presence or absence of the speck of gold will make the returns for the moil-sample jump all over the lot, but just what does that jumping amount to? Its presence or absence is purely accidental, and, as such, compensates more or less according to the law of the least squares. That is, the total error will tend to accumulate only as the square root of the number of samples, or, the error of the mean will approach that of a single sample, divided by the square root of the number of samples. I say 'approach,' because, with the wide accidental variations in samples, the laws of least squares are probably not strictly applicable. A little calculation will show that with the comparatively large number of moil-samples usually taken, the accidental errors are reduced to a point below our knowledge of other factors.

Unfortunately, this question of accuracy cannot be left with a discussion merely of accidental errors. One of the fundamental premises of compensating errors is that constant errors are eliminated. The consistent cutting of a disproportionate amount of softer or harder material of difficult richness within the same sample will introduce constant errors that no amount of averaging will eliminate, as will the jarring down into the sample of rich dust from other parts of the face. These are the disadvantages against which the moil-sample has to contend, but my experience has proved to my satisfaction that they can be successfully overcome by men of skill and patience without increasing the size of the sample. This is merely saying that moil-sampling is work of the head rather than the arm. Moil-samples can be cut evenly and accurately by one who knows his work. The employment of chalk-lines to delineate the sample, the use of plenty of sharp moils, and bagging the sample and starting a new one wherever a change of rock-structure occurs, will do much to eliminate this error. Similarly, a thorough scrubbing down of the face prior to sampling, and catching the cuttings in a small ordinary meat pan held close to the moil under a good light, will practically eliminate the danger of extraneous material falling into the sample.

(3) They must be detailed and specific. On these points the honors are all with the moil-sample. Well kept notes show the exact location of the sample for future inspection and re-sampling if necessary, as well as its exact length; details of the geological structure, any faults or shear zones, the amount and kind of rock inclusions, the character of the hanging and foot-wall, and many other details, according to the peculiarities of the mine being examined. It should be noted that the width sampled is an important item, as averages are based on a product on which any error in measuring the width has as great an effect as an error in the assay. All these details render possible the making of an accurate, detailed, and specific map of the property. Structure can be sketched in and correlated, and ore-shoots colored. Then, when the final analysis comes, when the interpretation of the problem arises, the engineer can have all the collected facts laid before him on a single plan with an accuracy, detailed and correlated, impossible with a more massive method of sampling.

This little exposition of my views would not be complete without touching upon two of the most troublesome phases of moil-sampling, namely, high assays, and the much abused sampling-factor. A complete argument on high assays would require a treatise, and I must content myself with a mere statement of the results of my experience. I believe that high assays, except in extremely rare cases, are best left alone. The theory of averages does not permit the removal of a high result. Re-sample in the same channel, by all means; but if the result is confirmed, do not reduce. If a very rich spot has occurred once, it will occur again in just the proportion indicated by your samples, provided one has enough to give the law of averages a chance. There is just one warning: see how much the few erratic assays affect the result, and as you have so shrewdly observed in your editorial, there cannot be many of them, otherwise they are not erratic. If, say, two or three samples change unpayable ore to payable, it is not correct to let matters rest, as it would in effect amount to making a decision on those two or three samples; but one cannot remove them any more than leave them in: it is neces-

sary to obtain more information. Regarding the sampling factor, I should like to throw out two suggestions for argument. I have known men to sample a vein with widths running all the way from 6 in. to 6 ft., and because the average width was greater than a stoping width, let the result alone. The experienced man knows that every sample must be taken over a stoping width, or must be diluted with enough waste to make it so. The effect of such an error by a thoughtless or untrained man is to increase the tonnage and decrease the grade. The second and greater pitfall is in making insufficient allowance for rock that will come in from the hanging or foot-wall. Some men do not realize the difference between a machine-drill and a moil, or perhaps I should say a machine-drill and a ruling-pen. The result is a map that cannot possibly be substantiated in mining, and the principle of moil-sampling gets the blame. A careful study of the character of the hanging and foot-wall will often show that there is no way of avoiding the breaking of a tremendous proportion of waste. If this is included in the grade and tonnage, and then partly eliminated in the treatment-calculations, the results will be much more nearly those subsequently obtained in operating. I believe the sampling factor is largely due to this error of including insufficient waste.

As long as expense is an item in mining, moil-sampling will be the great resource in examining prospects and small mines. The number of examinations made in this way is tremendous, and they are not always made by competent men. On the other hand, a mill-test is a rather elaborate affair and comparatively few of them are made. The man in charge is more likely to be carefully selected for the work. When a fiasco based on moil-sampling occurs, sight is lost of these facts, and because the absolute number of failures by moil-sampling is greater, the proportion of mistakes by the two methods is not looked into. As a result, the reliability of moil-sampling is questioned. There is, however, one part of the work where the mill-test comes into its own. After the moil-sampling has been completed and the results correlated, if there are available statistics from mill-tests or past operation, by comparing these with the results from moil-sampling for the same part of the mine much valuable information may be obtained as to exact mining and treatment-conditions and the sampling factor, if any. More accurate conclusions can then be drawn as to how nearly the moil-samples in the rest of the explored territory indicate what will be obtained by mining. This is the true function of the mill-test; it is purely corroborative. That mine valuation is not an exact science, and that there are many pitfalls to be avoided, I heartily agree. Nevertheless, I maintain that the best conclusions of the value of any deposit that can be obtained are based upon moil-samples, skilfully taken, and competently interpreted, by men of sound training and experience.

L. A. Parsons.

Cobalt, Ontario, May 24.

The Extra-Lateral Right

The Editor:

Sir—When we are considering the extra-lateral right feature of the mining law with reference to a proposed new law, Mr. Colby's estimate (in your issue of June 2) of the amount of mining litigation chargeable to the apex-law is not a fair representation of the subject. For the purpose of intelligent discussion of this matter it is equally to the point to consider the vast array of indirect costs. The few big cases which reach the reports of the higher courts are only the spot-light performances of the great tragedy. The host of cases which are not appealed to the courts mentioned are only the beginning of the additional charges which must be considered. We must count the cases filed in the courts which, after great expense in development work and professional reports, are settled by compromise. We must count the cases on which, after much expensive and useless underground exploration and map-making and professional work, both legal and engineering, and arbitration costs, settlements are made without even a court-filing. Further, and saddest of all, take the case of the miner drawn into a controversy over extra-lateral rights who finds that the expense of driving in barren portions of his vein, necessary to prove his case, together with the court, engineering, and legal expenses, is so far beyond his means that he simply succumbs to polite robbery. The success of his rival may be due either to superior financial means or to a more advantageous physical situation. The case may be one in which the apex claimant is in the right, or it may be that of a covetous neighbor with plenty of means, hunting up a geological condition that will enable him to go after something previously found by another beneath the surface. Further, the cost of securing the vast array of lode-claims which are located (without any legitimate discovery) and patented to 'protect' real mines from apex-hunters and the like must be charged to the extra-lateral law.

Senator Thomas is quoted as representing that the multitude of cases of mining litigation arise from surface contests. Quite true; but the cause of those contests is traceable directly to the apex-law. Without that feature of the law, and its accompanying feature of prediscovery, there would never occur the exasperating criss-crossing of mineral claims which causes the surface-litigation cases.

It is not the strict term 'litigation,' but the broader use, covering all of its expenses, direct and indirect, which is really in our minds when we discuss this subject in its bearing on the possible revision of the mining law. With this view I think Dr. Raymond's 99.9% is nearer the mark than Mr. Colby's 2%.

The law of the apex is upheld as a stimulus to the prospector. It was so intended, but the law of 1872 giving to mineral claims "all other lodes the apex of which are within the surface boundaries" is an iniquitous feature which is anything but an encouragement to the true discoverer; in fact, with the unnecessary surface allow-

ance of 600 ft. it offers greater encouragement to the land grabber as against the prospector.

Mr. Colby's eleven "summarized statements" I consider generally well chosen and acceptable, but I must take exception to numbers 7 and 10.

In the case of No. 7 the extra-lateral right feature does not apply; it is only the application of the antecedent discovery requirement which gives the advantage to the agricultural claimant, and to prevent this it is true that the logic of the situation leads to the necessity of separating surface and mineral titles. See below under No. 9.

No. 10 is a bugbear regularly brought forward by those who would retain the apex-law. To begin with, the supposed confusion over the application of a new law at most only applies to old mining districts, and even there it seems to me to be a false alarm. Rights already acquired cannot be affected and the means of defending them can never be worse than now. A new-law mining claim without extra-lateral rights located in a nest of old-law claims would secure only what the older locations had not already acquired. Everyone would understand that. The new locator could not in any sense threaten his older neighbors. The operation of a law eliminating extra-lateral and antecedent discovery features would be to lessen litigation in old districts while preventing it in the new.

No. 9 is a statement with which I fully concur and which I regard as the most important fact to keep in mind in any discussion of this subject. Indeed in the number of the cases of disputed titles and the incompatibility with physical conditions the antecedent discovery feature is worse than the apex-law. And further it is the antecedent discovery feature, or the abuse of it by presumption, that is used in all sorts of right-of-way, timber, water, and building-site frauds. My views on this matter have been given in the discussion on the article by E. D. Gardner on the antecedent discovery requirement (Bulletin 120, A. I. M. E., December, 1916, p. 2202). In brief, I regard the complete divorce of surface and mineral titles as the only logical solution of the mining-law problem.

Denver, June 13. V. G. Hills.

Shift Bosses, Good and Bad

The Editor:

Sir—During 1915 I was employed by an Idaho mining company as miner. Aside from the necessity of earning a living, I had 'rustled' that particular mine to gain a practical knowledge of methods employed. At this property one is apt to be impressed by the general efficiency so much in evidence, and were I one of the stockholders making a visit, I might congratulate the management while I spent my monthly dividends, and think there was no room for improvement. To the miner, however, the case is different. The 'Moguls' we miners worried about were the shift-bosses, and as our aptitude for the day's work was usually influenced by the 'shifters' I know the stockholders often got the worst of the deal. The impression is general that any thorough miner makes a competent shift-boss. Having worked under three shift-bosses in that mine, I found the ideas as to what constituted a fair day's work to vary so that I thought the situation worth studying, particularly as the characters of the men varied but little. From my deductions I believe a large proportion of the trouble between capital and the man who piles it up could be avoided by a little more intelligent attention in the selection of subordinates by superintendents. As an illustration, I shall name two shift-foremen Page and Sage. Both of these men were first-class miners, and to their superiors they were good fellows, each doing his best in the interest of his employers, as his judgment dictated. As the shift starts work, Page and Sage go through the stopes on their respective levels. Page seeks an opportunity to dig into the men and speed them up; he always finds a number of cases, due often to many little causes not necessarily the miners' fault. In this case, the miner or mucker gets a grouch that is increased by this fault-finding, and he doesn't give a 'whoop in Hades' whether his holes break or not, just so he gets a showing; if mucking, he's apt to throw good ore in the gob and as much waste as he dares down the ore-shoot; he wastes powder and time; handles tools carelessly; doesn't cover the stope floor before shooting; leaves machines and tools exposed to flying rock, and the like, and thinks he's getting even with the whole works. On the other hand, Sage forgets that his night's sleep may have been spoiled or that his digestion is bad, and makes his round with a cheery word for each man. He may not remember Bill from Mike, but he's looking for trouble, not to raise Hell about it, but to give a hand if need be, or a word of advice, and the result is that he starts the day right for each man. They know they can ask advice from Sage, but they will not risk Page's displeasure by doing so. Sage realizes that in these mad days you must make miners of any promising material, and draws from his fund of experience. Page expects miners to be ready-made, and hoards his experience, because he believes he will lose prestige by acting human. Page is always going the rounds of the stopes watching the men and 'digging in.' Sage puts in most of his time with the green men, and as he's sincere in his desire to teach, it is seldom resented; he knows at the end of a shift whether a man has done a reasonable and profitable day's work, and he makes allowances for unusual conditions; the men feel that they are trusted as men, and not driven as mules, and the company benefits accordingly. But Page never has a word of praise for creditable work. Sage has, but he does not make the mistake of piling it on too thick, and he doesn't play favorites, and he divides bad or wet places as equally as possible. One tells of the faithful and intelligent work that his men do, while another writes that his men will not do more than they positively have to in order to hold their jobs. What's wrong? A man like Page adds fuel to the flames of class hatred and discontent, and the sooner he's found out and sent back to a job timbering or mining, the better.

Ravalli, Montana, May 25. Miner.

Replacement of Sulphides by Quartz

By H. N. WOLCOTT

*Among the many cases of replacement of one mineral by another, that of quartz or silicates by pyrite, or even other sulphides is not uncommon, but the reverse of this process does not appear to have been recorded. The case described therefore seemed worthy of record. The specimens were obtained from the Old Town mine, in Russell gulch, Idaho Springs, Colorado. In the rough, they appeared to consist largely of chalcopyrite, with grains of tetrahedrite. The polished surface of some of the lumps, however, showed numerous rounded grains of pyrite, and minute fractures. These smooth surfaces studied by reflected light under the microscope exhibited interesting relationships. It was seen that while chalcopyrite and tetrahedrite were probably contemporaneous, numerous grains and rosettes of pyrite, of varying size were scattered through the chalcopyrite. A few were seen in the tetrahedrite. As the pyrite is completely surrounded by the chalcopyrite (and also the tetrahedrite) it may be of earlier age. The pyrite rosettes and grains consist in some instances entirely of that mineral. In other cases, by far the most numerous, the rosettes show an irregular central mass of quartz and often connecting with the exterior by one or more veinlets of quartz. Some show a little quartz on the outside of the pyrite grain, and in one case the quartz surrounding the pyrite showed the crystal outlines of quartz. The quartz, in addition to its occurrence in the pyrite grains, fills numerous narrow fractures in the chalcopyrite and tetrahedrite; indeed in some parts of the specimen, the chalcopyrite and tetrahedrite have been crushed to a mass of angular fragments with quartz filling the crevices. The quartz veinlets passing through the chalcopyrite and tetrahedrite are usually clean cut, and form connecting lines between the quartz in the pyrite rosettes. In places, however, the quartz veins enlarge and project into the chalcopyrite and tetrahedrite in such an irregular way as to suggest replacement. Some of the areas in the tetrahedrite might be regarded as contemporaneous with the sulphide were it not for their connection with the feeding channels. Following the deposition of the sulphides, fracturing of the ore occurred, resulting in the introduction of silica that was deposited in the chalcopyrite and tetrahedrite largely as fillings of fractures, but in the chalcopyrite at least in part by replacement. In addition it was deposited in the pyrite almost wholly by replacement.

*Abstract: Trans. A. I. M. E., for October 1917.

REGULATION of freights, as carried out by the British Government, extends to the fixing of preference-cargoes, and this is done in all ports of the world. For example, administrative orders have selected certain products from Bolivia as being more urgently needed than tin, in consequence of which tin is moving forward at an extremely slow rate. The ocean freight rate quoted on Bolivian tin concentrate to England is nominally £10 per ton, and insurance is 3.3%. The Bolivian Government is alarmed over the situation, fearing a virtual collapse of the tin-mining industry, which would strike a severe financial blow at the prosperity of the Republic.

Preparation of Pure Molybdenum

A paper presented by C. H. Humphries, of the Commercial Research Co., Long Island City, New York, on Molybdenum, at a recent meeting of the New York section of the American Institute of Mining Engineers, was devoted chiefly to the preparation of pure grades of molybdenum. He reviewed briefly the geology of molybdenum ores and showed samples of molybdenite and wulfenite. Molybdenite, MoS_2, is the principal source of metallic molybdenum. It is reduced by carbon in an electric furnace. The ordinary methods, however, produce a metal which contains some carbide, and in order to obtain pure molybdenum the trioxide or the ammonium molybdate has generally been used, as the starting point. The molybdate is made from the sulphide, and this is reduced in an atmosphere of hydrogen in an electric furnace, producing a crystalline material which passes through several stages of purification. The process is analogous to the well known General Electric tungsten-reduction process. This crystalline product is placed in a nickel or nickel-plated boat in a gas-furnace and heated to 900° to 1000°C. It is then crushed and screened, and reduced again for several hours at 1200° C. It is then examined for oxide by inspection. It appears streaky if oxide is present. If a blue tint is observed on shaking in water, oxide is present. It would be desirable to reduce finally at about 1400°C., but there is danger of the material becoming contaminated with iron if a nickel-plated iron boat is used. It is desirable to have less than 0.01% of iron if molybdenum wire is to be made. After the final reduction the metal is powdered, then pressed in a steel mold, and heated in an electric furnace for about a half hour at 1200–1300°C. The metal sinters and becomes hard, but is not yet suitable for working. It is then placed in a furnace, the air displaced, and a current of about 100 amp. passed through the metal. It shrinks and forms a true molybdenum rod. It is then swaged and made into smaller rods, wire, foil, and other forms. The swageing is done hot from the electric-furnace at about 1400°C. The metal runs through dies of high-speed steel down to 0.001 in., the smallest size for practical purposes being 0.005 to 0.01 in. If the pure metal is heated to 1200°C. several times and quenched the surface can be made glass-hard. Some molybdenite contains calcium and barium, and these are hard to keep out of the metal. They prevent working of the metal even when less than 0.1% is present.

Molybdenum was proposed as a substitute for platinum in jewelry. It is just as beautiful, and is permanent, and can be produced at present for 25c. per gramme.

Saline Valley Tramway

By F. C. CARSTARPHEN

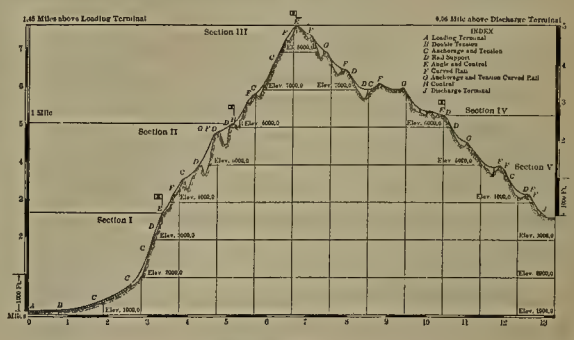
*Saline valley is situated in Inyo county, California, about 20 miles north-east of Owens lake. It is separated by the Inyo mountains from the Southern Pacific railroad running through Owens valley. The valley has no outlet, but there are several large springs and a constant flow of water in Hunter canyon. There is a large deposit of salt covering about 1500 acres of the floor of the valley. The existence of this salt deposit has been known for some time, but lack of transportation facilities prevented its commercial development. Topographic conditions render the economical construction of a railroad into the valley impracticable. A pipe-line across the Inyo mountains by which brine could be pumped to evaporating-vats near the railroad in Owens valley was also considered, but this plan was abandoned. While it was found feasible as a means for transporting the brine, it did not provide for bringing in supplies needed by the operations incidental to collecting the salt and pumping. Accordingly an aerial tramway was given the preference. After the surveys were completed, a contract was let by the Saline Valley Salt Co. to the Trenton Iron Co., a subsidiary of the American Steel & Wire Co., for the construction of a Trenton-Bleichert tramway. It was designed to carry salt weighing 60 lb. per cu. ft., the slope-length being 69,645 ft., the capacity, 20 tons per hour, the elevation of the discharge-terminal above the loading-terminal, 2450 ft., the carriers to have a volume of 12 cu. ft., and the speed of the traction-rope to be 500 ft. per minute. This required a spacing of 525 ft., or an interval of 63 seconds between carriers. About 112 hp. is required for the operation of the tramway. The principal equipment exclusive of structures and operating machinery is as follows:

1¼-in. steel track-cable, feet	13,850
1⅛-in. steel track-cable, feet	55,450
⅝-in. steel track-cable, feet	69,300
¾-in. steel traction-rope, feet	141,000
Steel buckets	286
Track-cable saddles	240
Steel traction-rope rollers	240

From the loading-station at the edge of the salt-field, which has an elevation of 1060 ft., the tramway runs south along the mesa for 2¾ miles to the eastern foot of the mountains, at an elevation of 1800 ft. From that point the ascent is rapid to the control station No. 1, where an elevation of 3720 ft. is attained. This part of the line is known as Section I. At station No. 1 there is a horizontal angle of 35°30′. Section II extends to control station No. 2, which has an elevation of 6100 ft. Section III extends to control-station No. 3 at the summit, where there is a horizontal angle of 2°28′. Section IV extends to control-station No. 4, which has an elevation of 6330 ft. At this point there is a horizontal angle of 10°48′. Section V extends to the discharge-terminal on the narrow-gauge line of the Southern Pacific railroad. The elevation is 3625 feet.

*Abstract: Proc. Am. Soc. Civil Eng., by F. C. Carstarphen, tramway engineer, American Steel & Wire Co., Trento, New Jersey.

MAP OF SALINE VALLEY AND THE TRAMWAY



PROFILE OF LINE

For transportating material on the western slope of the mountains, it was possible, by making use of an old road and extending it, to construct a wagon-road to the summit, the total distance from the valley being 10 miles. At one point on this road there was a stretch of 300 ft. with a grade of 25%, and this grade could not be eliminated or reduced except at prohibitive cost. This became the ruling grade for hauling material between control stations 4 and 1, and limited the maximum load for eight-horse teams to 5000 lb., heavier loads requiring 10 or 12 horses. A camp was established 3½ miles west of the summit. Teams made one round trip per day between the railroad and the camp. Those quartered at the camp hauled the wagons from that point to the summit, where the material was unloaded, three round trips being made in two days. For every 100 tons of construction material hauled from the railroad to the camp, 1.5 tons of grain, 7.7 tons of hay, and 33 tons of water had to be transported. The cost of maintaining a team consisting of eight horses and a driver was $15 per day at the railroad. On account of hauling feed and water from the railroad, the cost of a team at the camp was $21 per day. Construction of roads on the eastern slope of the Inyo mountains was found impracticable, although a trail was constructed from the summit to Saline valley. Since a large part of the machinery was too heavy to be moved by pack-animals, temporary double-cable reversible tramways were constructed for transporting material for the structures on Sections I and II. The diameter of the track-cables used was ¾ in. and of the traction-rope, ⅝ in. The cost of transporting this equipment from the end of the wagon-road at the summit was as follows: 600 tons of material was moved 8300 ft. at a cost of $4.20 per ton; 375 tons 2600 ft. farther at a cost of $2; 260 tons 4000 ft. farther at $3.50; and 210 tons 2700 ft. farther at a cost of $2.90 per ton.

The cost per day for the crew to operate, load, and unload these temporary cableways was from $35 to $42. The capacity in tons per day, while operating, ranged from 13.3 to 33.3 tons. Allowing for the time required for constructing, taking down, and moving, the capacity ranged from 6.3 to 19.3 tons. The material for control-station No. 1 was carried on a temporary cableway from the floor of Saline valley. A wagon-road runs from Big Pine on the railroad, 55 miles to the floor of Saline valley. About 375 tons of material was hauled over this road at a cost of $35 per ton. Some of the other material was moved from the summit down Daisy canyon on a sort of sled. The cables between the summit and control-station No. 2 were strung by letting them down the mountain-side by gravity. From three to five men were required at the lead-end to put the cables on the traction-rope guide-sheaves at the towers and stations. Wooden blocks 4 by 8 in., bolted together, were used as brakes to control the velocity of the cables. From the floor of Saline valley to control-station No. 1 the cables were handled with a winch driven by a gasoline-engine. On Sections IV and V the cables were strung and placed under tension in the usual manner, except that on Section V the grade was sufficient to make it desirable to use the gravity method. In placing the traction-rope for Sections II and III, it was threaded around the grip-sheave at the summit station. The grip-sheave acted as a driving-sheave, because of the use of a brake on the reel, which imposed tension in the traction-rope before it passed around the grip-sheave. The traction-rope was also passed through hauling-clamps before reaching the grip-sheave, in order to hold it when splices were being made, or in cases of emergency. After bringing the traction-rope for one side to control-station No. 1, the upper end at the summit was snubbed and the rope for the opposite side was let down in the same manner. After the upper ends had been spliced, the ropes were cut at control-station No. 2 and passed around the tension and grip-sheaves of this station.

The towers and structures are carried on concrete foundations, the water required for making the concrete being hauled in tanks or packed by mules for distances ranging from 1 to 7 miles. This was also necessary for the water required for the camps, except those at the railroad, in Daisy canyon, and at Saline valley.

The tramway was completed and the first bucket of salt hauled on July 2, 1913, power being obtained from the Los Angeles aqueduct. The line worked satisfactorily when the buckets were loaded about two-thirds full. When efforts were made to carry full buckets, it was found that the number of accidents resulting from carriers slipping on the traction-rope was excessive. An investigation showed that while the tramway had been designed to carry air-dried salt, which weighs 60 lb. per cu. ft., the average weight of the wet salt was 80 lb. per cu. ft. It was also noted that while buckets loaded with dry salt were carried without difficulty, when wet salt was being transported, a few of the buckets would slip on the traction-rope, particularly on the steeper parts of the tramway. With the exception of the first 2½ miles on the floor of Saline valley, the cables throughout almost the entire line had a slope exceeding 30%, and in some cases this slope exceeded 85%.

The principal departure from standard tramway-practice was the division of the distance between the loading-terminal and the summit into three sections, and the distance between the summit and the discharge terminal into two sections. Experience has shown that it is not economical to attempt to use traction-ropes of large diameter. The total stress developed in such ropes when lifting 20 tons of material through a vertical distance of 1½ miles at a rate of 500 ft. per minute is too great to permit the use of a single rope. Multiple traction-ropes, arranged in parallel, are not satisfactory. Accordingly, the tramway was constructed in sections so as to permit the use of a traction-rope of moderate diameter. The stations were arranged so that there would be a constant difference in their successive elevations, giving essentially the same stress on the traction-rope of each section. These stresses, however, are not absolutely constant, because the friction developed by the moving carriages varies with the length of the different sections. Ex-

perience has shown that, irrespective of the constancy of tension in two traction-ropes in service, they do not maintain precisely the same diameter. Consequently, friction-grips that will hold satisfactorily on the larger of

BUCKET LEAVING LOADING-TERMINAL

the ropes are likely to slip on the smaller one. For this reason the Webber grip was not used. The Pohlig screen-grip was also rejected because of the acceleration required to close the gripping-lever, which moves in a plane

BUCKET OF SALT AT LOADING-TERMINAL

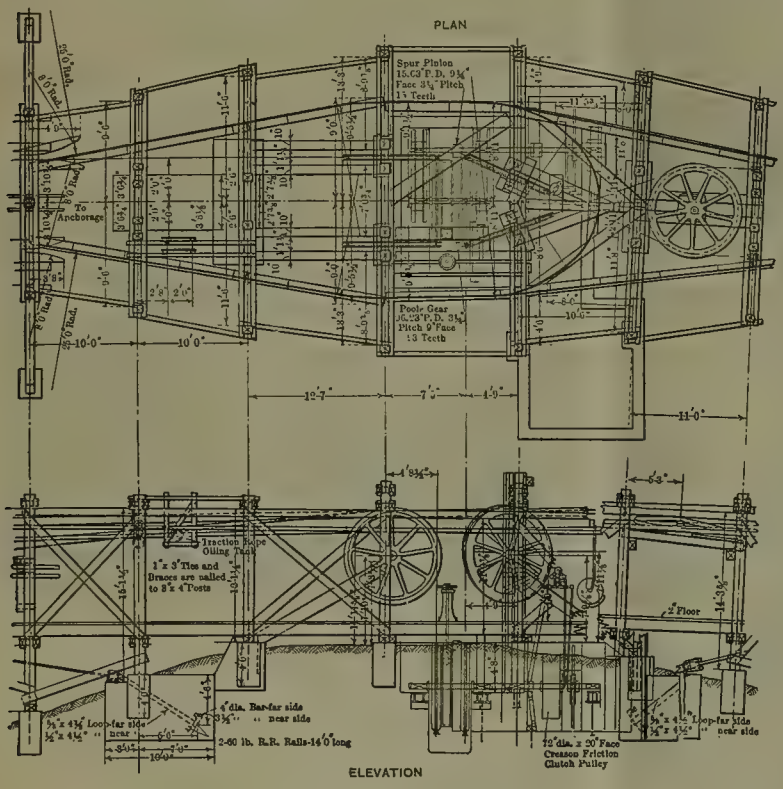
parallel with the direction of motion; also because of the difficulty of maintaining a proper limit for the throw of the closing-lever when operating on ropes of different diameters, so as to engage the detacher properly instead of under-running it. The overhead Bleichert-grip was rejected because the tension of the traction-rope in passing through the structures on the crests tended to overturn the carriers, especially those on the empty side. The under-hung Bleichert-grip was rejected because it is operated by the weight of the load acting on the movable jaw, and it was feared that on the steeper grades this would not be sufficient to keep the carriers from slipping on the rope. This type of grip and carriers is also expensive as compared with others. This is an important consideration in view of that fact that 286 carriers were required. A special grip of the under-hung, top-opening, trunnion type was therefore designed. These grips were used on the line for some time, but were not satisfactory, slipping occasionally on the extreme slopes, because of the variation in the weight of the salt.

SALINE VALLEY FROM POINT NEAR SUMMIT

Finally the American Steel & Wire Co. took over the operation of the line in order to determine what defects existed and what replacements should be made. As a result of this investigation, a new grip, the Universal Wico, was designed, and it has been used from that time with satisfactory results. This grip requires a force of about 40 lb. on the closing-lever to fasten it. It will hold a carrier loaded with wet salt on the steepest grades. A special lubricating-system is attached to the carriers to provide an adequate supply of oil for the wheels and pins.

Sections III and IV are controlled from the summit, both driving-sheaves being mounted on the same shaft. The power developed by the descending loads on Section IV assists in raising those on Section III. As the carriers on Sections I, II, and III are being lifted, there is a possibility of the line reversing its direction of motion, on account of the unbalanced weight of the carriers on the two sides. Accordingly, each of the stations is equipped with a reverse-preventer. This consists of a large circular plate fitted with shoes containing ball-races, which are under the control of a centrifugal governor. When the governor is up to speed, the balls are restrained so that the plates run freely. When the line

stops the balls immediately nip the plate, and a reversal of motion is prevented. The drives at the stations are similar in design, except that, as already mentioned, the two sheaves at the summit are mounted on the same shaft. The drives consist of an 8-ft. grip-sheave bolted to a brake-run 7 ft. 2 in. diam., with a 12-in. face, and this, in turn, carries an 8-ft. spur-gear. The latter is driven by an 18-in. pinion mounted on a shaft fitted with a friction-clutch belted to a 75-hp. Allis-Chalmers, 3-phase, 2200-volt, induction motor. On Section V, this motor acts as a dynamo-brake instead of serving as a driver.



CONTROL-STATION AT SUMMIT

The grip-sheaves carry a special rim, in which there are 96 pairs of toggle-jaws. The jaws are held open by gravity or by a special flat spring. When the traction-rope passes around the sheave, the pressure developed on the bottom of the groove on the jaws is sufficient to cause them to close and grip the rope tightly. This increases the friction between the sheave and the traction-rope, augmenting the efficiency. The brakes are of the compound-differential type, and are actuated by hand-wheels and screws. This ensures their being applied gradually, so that the line may not be wrecked by sudden stoppage, as might be the case with brakes operated by a solenoid.

The hangers on the carriers are made longer than in standard practice, so as to provide clearance between the traction-rope guide-rollers used in the rail-structures on the ridges that run transversely to the line of the tramway. The buckets are covered to prevent dust from reaching the salt. The covers are provided with a special latch to prevent their being blown open by the high winds that frequently occur. The control-stations are equipped with telephones, and the line-riders also carry telephones, which may be attached to the line at any point, in addition to which there is a bell-signal system. The electrical transmission-line is of the usual pole-construction, carrying copper wires for a 3-phase circuit. The transformer-stations are of the out-door type. The line-voltage is 33,000, which is stepped down to 2200 for use in the motors of the driving stations. The crew consists of two men each at the loading and discharge-stations and at the four control-stations on the line. There are also four line-riders and a foreman who has general supervision of the entire line. The tramway carries 23 to 24 tons of salt per hour at a cost for labor and power of 4.6c. per ton-mile. The line is not designed for passenger-service, but the line-riders use it in preference to following the rough trails on horseback.

Several methods of gathering the salt have been tried with varying success. At present the plan is to flood the salt-field with water piped from the springs. The fresh water dissolves the salt rapidly. If the supply of fresh water is then stopped, evaporation caused by the summer sun is excessive, and pure salt-crystals gather in the brine, resembling flat plates that are easily shoveled into conical piles about 2 ft. high and 3½ ft. in diameter at the base. Each pile is assumed to contain from 400 to 500 lb. The piles are arranged in rows approximately 12 ft. apart, the spacing between the piles being 6 ft. Mexican labor is found to be most satisfactory in gathering salt. Each man piles from 8 to 10 tons per day. Theoretically, the salt remains in piles until the brine has drained. As the mother liquor contains most of the impurities which might contaminate the salt, this step is an additional insurance of its purity. However, the salt does not drain freely, but remains damp for a considerable time. When the salt is gathered, a buggy of a special type is used, made of galvanized iron and having a body with a channel-like cross-section. Since the ground is soft, the rear wheels are 20 in. diam. and have a 12-in. face. The front wheels are 16 in. diam. and have a 4½-in. face. The bed is 3 ft. wide, 8 ft. long, and 6 in. deep. The axles are attached rigidly to the body, so that curves are turned by slipping the front wheels. These buggies carry from 500 to 1000 lb. of salt, and are hauled across the field by a ⅜-in. cable operated by a gasoline-engine. At the dumping-point the buggies are pulled up an incline plane until they assume an angle of approximately 44°, at which slope the wet salt slides freely into

a hopper above a car which has a body 30 in. wide, 4 ft. 6 in. long, and approximately 30 in. high. The bottom of this car is hoppered both ways at an angle of 45°, so that the sides, instead of the ends, are used for doors. These cars are operated on a double-track railway, about ½ mile long, by an endless-rope haulage-system operated at a speed of 200 ft. per min. A 10-hp. gasoline-engine moves seven loaded and seven empty cars on these tracks. The cars dump into a boot serving a drag-conveyor, which elevates the salt to a point high enough to command the 50-ton bins at the loading-terminal. Here the tramway-buckets are filled by a lever-chute of the ordinary type. The bucktes are dispatched from the loading-terminal at the tap of an automatic gong. The rate established is 56 buckets per hour.

White Smith was president, W. H. Leffingwell, chief engineer, Daniel Kuhnle, superintendent, M. O. Bolser, electrical engineer, and Harry Hilderman, foreman of construction for the Saline Valley Salt Co. Among the engineers of the Trenton Iron Co. and the American Steel & Wire Co. who took part in the construction of the tramway were S. S. Webber, F. C. Carstarphen, William Hewitt, C. H. Wickham, L. T. Hays, T. J. Murphy, R. H. Hall, and George Hall.

Graphite

A market for graphite exists among manufacturers of graphite crucibles, pencils, and lubricants. Perhaps the largest single use of graphite is in lubrication. The ideal form for lubricating purposes is the exceedingly thin flake-graphite, that coming from the Ticonderoga district in New York State being the standard of reference in this country for thinness of flake and for purity. The amorphous variety of graphite is objectionable for this purpose on account of its tendency to cake in the gearing. For the making of crucibles graphite should have a thick body, and should possess the characteristic known in the trade as 'sharp,' which implies a well-defined shape, lustrous, and free from a tendency to break down into smaller scales and non-lustrous powder. The best material for crucibles was formerly obtained from the mines in Ceylon, but in recent years large shipments of suitable graphite have been made from the deposits in Madagascar. Pencil-graphite contains chiefly the amorphous variety, with enough of the flaky sort to impart smoothness. Formerly Bavaria and Siberia supplied the larger proportion of the pencil-graphite used in this country, but today practically our entire demand is met by the output of the Mexican mines, a small quantity also coming from Korea. The physical properties of graphite control its application and its consequent value to the manufacturers more than its chemical composition. Accordingly graphite is universally sold on sample. Local assayers do not possess the equipment for making the necessary physical tests, and as the adaptability of graphite is a matter developed in the art of manufacture it is difficult to express the desirable qualities in such scientific terms as would not be open to misinterpretation in the hands of men inexperienced in this special industry. On satisfactory evidence that a sample accurately represents amounts available in excess of carload lots the large manufacturers, such as the Joseph Dixon Crucible Co., the Franco American Chemical Co., Inc., R. M. Hollingshead Co., U. S. Graphite Mills, and Whitaker & Co., will test a sample submitted to them, and will quote the true market price in accordance with the estimates their experts make as to its peculiar fitness for their needs. Amorphous graphite is not amenable to froth-flotation, but the lustrous flake-graphite usually yields a concentrate by that process.

Metallurgists Needed by the Government

The United States Civil Service Commission announces competitive examinations for metallurgists as follows: A vacancy in the Springfield Armory, Ordnance Department at Large, Springfield, Massachusetts, at $3000 per year, and future vacancies requiring similar qualifications, at the Springfield Armory or elsewhere, will be filled from this examination. The duties of this position consist in the superintendence of the acceptance-tests of steel and oil, and of the heat treatment of dies and tools. The applicant should have had experience in the chemical analysis and the photomicrographical examination of steel, and in the prescription and supervision of the heat-treatment of tools. A vacancy in the department of ordnance, navy yard, Washington, D. C., at $2000 per year, and future vacancies requiring similar qualifications throughout the United States will be filled from this examination. The duties of this position will be the laboratory control of the melting operations in the manufacture of open-hearth, converter, and electric-steel castings and ingots; non-ferrous mixtures; the heat-treatment of forging and casting of both alloy and carbon-steels; the interpretations of physical and chemical tests, and their application to shop operations. Until further notice and on account of the urgent needs of the service, applications will be received at any time, and the papers will be rated immediately upon their receipt, in order that appointments may be made with the least possible delay.

ZINC-OXIDE is made by mixing the raw crushed ore with fine anthracite, and charging it into furnaces built on the plan of a fire-box, provided with an under-grate blast of air. The furnace-chamber is closed by a door. The furnaces are placed back to back, and each block of furnaces discharges the fume into sheet-iron flues which convey it to the collecting system, under draft from a suction-fan. The collection is accomplished in a bag-house. The oxidized ores are necessary for this process. Zinc-blende must be roasted previously. Any lead present in the blende re-appears in the final product as lead sulphate. Leaded oxides are graded according to color and content of lead sulphate, ranging from 5 to 30% of that compound.

The Empirical Formula in Milling Control

By A. J. SALE

The formula for calculating the ratio of concentration and percentage of extraction from assays of the heads, tailing, and concentrate, without having the corresponding weights, is called the empirical formula. This is really a misnomer, since the formula, being based entirely upon theory and not experiment, is in reality the reverse of empiric. Engineers know how this formula is derived, but few have made sufficient study of it to enable them to state to what extent it may be trusted, that is, fully to understand what effect errors of sampling and assaying will have upon the results.

The derivation of the formula is as follows: Let $H =$ assay of heads; $T =$ assay of tailing; $C =$ assay of concentrate, assays being in ounces for gold and silver, and in percentages for copper, lead, and other metals. Also let $R =$ ratio of concentration; $E =$ extraction, the extraction being a decimal fraction which must be multiplied by 100 to give the percentage. Assume that one ton of heads will make X ton of concentrate, X being a fractional part of a ton. After the X ton of concentrate has been removed from the 1 ton of heads, there will remain $1 - X$ ton, which represents the weight of the tailing. Now the amount of metal in the 1 ton of heads is $1.H = H$. The amount of metal in the X ton of concentrate is XC, and the amount of metal in the tailing is $(1-X)T$. But, since the amount of metal originally contained in the heads either goes into the concentrate or into the tailing, $H = XC + (1-X)T = XC + T - XT$.

Therefore,

$$X(C-T) = (H-T)$$

Or

$$X = \frac{H-T}{C-T}$$

Now 1 ton of heads produces X ton of concentrate, therefore $\frac{1}{X}$ ton of heads will produce 1 ton of concentrate. Hence the ratio of concentration is

$$R = \frac{1}{X} = \frac{C-T}{H-T}$$

In verbal statement this formula expresses: The ratio of concentration equals the assay of the concentrate less the assay of the tailing, divided by the assay of the heads less the assay of the tailing.

Since the extraction is the ratio of the amount of metal saved in the concentrate to the amount originally contained in the heads,

$$E = \frac{XC}{H} \qquad \text{But } X = \frac{H-T}{C-T}$$

Hence $E = \frac{(H-T)C}{(C-T)H}$ But $R = \frac{C-T}{H-T}$

Therefore $E = \frac{C}{HR}$

Expressed verbally this formula means: The extraction equals the assay of the concentrate divided by the product of the ratio of concentration and the assay of the heads.

This is a convenient formula where a good slide-rule is handy, but personally I prefer one which is entirely by division, without awkward figures. To obtain such a formula: Let $A =$ the apparent extraction, or $\frac{H-T}{H}$.

$$\text{Now, } E = \frac{C}{HR} = \frac{(C-T)+T}{HR} = \frac{C-T}{HR} + \frac{T}{HR} = \frac{(C-T)}{(H-T)}\frac{(H-T)}{HR} + \frac{H-(H+T)}{HR}$$

$$\text{But } \frac{C-T}{H-T} = R$$

$$\text{Therefore } E = \frac{R(H-T)}{HR} + \frac{H-(H-T)}{HR} = \frac{(H-T)}{(H)} + \frac{1-\frac{(H-T)}{(H)}}{R}$$

$$\text{But } \frac{H-T}{H} = A \qquad \text{Hence } E = A + \frac{1-A}{R}$$

Expressed as a percentage, this formula is: $100\,A - \frac{100-100A}{R} =$ per cent of extraction.

This is the most easily operated of any extraction formula; to use it, subtract the assay of the tailing from the assay of the heads, and divide by the assay of the heads; multiply the result by 100 to express the percentage. Take the difference between this percentage and 100 and divide it by the ratio of concentration; add the quotient to the first percentage and the result will be the percentage of extraction.

Having derived satisfactory formulae, next determine the effect of errors in H, T, and C. This is best done by applying one of the first principles of calculus. Since there is a probability of error in H, T, and C at the same time, it will be necessary to assume that all of them are variables.

Take the equation $R = \frac{C-T}{H-T}$

Differentiating and simplifying, we find $d,\, R = -\frac{(C-T)}{(H-T)^2}\cdot d,\, H + \frac{(C-H)}{(H-T)^2}\cdot d,\, T + \frac{1}{(H-T)}\cdot d,\, C = -\left[\frac{(C-T)}{(H-T)^2}\cdot d,\, H - \frac{(C-H)}{(H-T)^2}\cdot d,\, T - \frac{1}{(H-T)}\cdot d,\, C\right]$

Also take the equation $E = \frac{(H-T)C}{(C-T)H}$

Differentiating and simplifying, we find

$$d,\, E = +\frac{CT}{(C-T)H^2}\cdot d,\, H - \frac{C(C-H)}{H(C-T)^2}\cdot d,\, T - \frac{T(H-T)}{H(C-T)^2}\cdot d,\, C.$$

In the above formulae, d, R equals the change in the ratio of concentration due to errors in sampling or assaying of heads, tailing, and concentrate; d, E equals the change in the extraction due to the same errors; d, H equals the actual error of H; d, T equals the actual error of T; d, C equals the actual error of C.

If we make $R' = R + d, R = R - \left[\frac{(C-T)}{(H-T)^2} \cdot d, H - \frac{(C-H)}{(H-T)^2} \cdot d, T - \frac{1}{(H-T)} \cdot d, C\right]$ and replace (d, H), (d, T), and (d, C) by actual values which are determined by experiment, one can then approach a true empirical formula which shows the limits to which the calculated ratio of concentration may be trusted.

In like manner, make $E' = E + d, E = E + \left[\frac{CT}{(C-T)H^2} \cdot d, H - \frac{C(C-H)}{H(C-T)^2} \cdot d, T - \frac{T(H-T)}{H(C-T)^2} \cdot d, C\right]$

For a practical application of this principle, assume that, in a flotation-mill operating on copper ore, there is made a series of duplicate samples of heads, tailing, and concentrate, under conditions as variable as possible in conformity with accuracy. If this work be properly performed, one is entitled to assume that the mean-assay represents the true values of H, T, and C. Then the variations between the originals and duplicates from the mean will represent the most probable errors, or (d, H), (d, T), and (d, C).

Suppose that the assays be as follows:

	Original samples	Duplicate samples	Mean	Variation from mean
	%	%	%	%
H	2.00	2.40	2.20	0.20
T	0.25	0.15	0.20	0.05
C	10.70	9.70	10.20	0.50

From the above table it is seen that

	%
$H =$	$2.20 = 0.022$
$T =$	$0.20 = 0.002$
$C =$	$10.20 = 0.102$
$d, H =$	$0.20 = 0.002$
$d, T =$	$0.05 = 0.0005$
$d, C =$	$0.50 = 0.005$

The errors may be either + or −; and, for studying maximum probable errors the signs producing maximum variation must be selected. It is seen that in the formula

$$R' = R - \left[\frac{(C-T)}{(H-T)^2} \cdot d, H - \frac{(C-H)}{(H-T)^2} \cdot d, T - \frac{1}{(H-T)} \cdot d, C\right],$$

if d, H is taken at opposite sign from d, T and d, C, then R' will either become maximum or minimum according to whether d, T and d, C are taken as positive or negative. Also in the formula

$$E' = E + \left[\frac{CT}{(C-T)H^2} \cdot d, H - \frac{C(C-H)}{H(C-T)^2} \cdot d, T - \frac{T(H-T)}{H(C-T)^2} \cdot d, C\right]$$

if d, H be taken at opposite sign from d, T and d, C, then E will either become maximum or minimum according to whether d, T and d, C are taken as negative or positive.

To apply the results from the above table, assume that d, T and d, C are positive; this forces d, H to be negative, if extreme probable variations are to be shown.

For the tabulated figures:

$$R = \frac{C-T}{H-T} \cdot \frac{(0.102-0.002)}{(0.022-0.002)} \cdot \frac{0.100}{0.020} = 5$$

That is, five tons of ore will produce one ton of concentrate.

$$A = \frac{H-T}{H} = \frac{(0.022-0.002)}{0.022} = \frac{0.020}{0.022} = 0.909$$

$$E = A + \frac{1-A}{R} = 0.909 + \frac{0.091}{5} = 0.927$$

That is, the extraction is 92.7%.

$$d, R = -\frac{(C-T)}{(H-T)^2} \cdot d, H + \frac{(C-H)}{(H-T)^2} \cdot d, T + \frac{1}{(H-T)} \cdot d, C = -\frac{(0.102-0.002)}{(0.022-0.002)^2} \cdot (-0.002) + \frac{(0.102-0.022)}{(0.022-0.002)^2} \cdot (0.0005) + \frac{1}{(0.022-0.002)} \cdot (0.005) = \tfrac{1}{2} + \tfrac{1}{10} + \tfrac{1}{4} = 0.85.$$

Now a complete change of signs for d, H, d, T, and d, C will give this same figure with opposite sign.

Therefore $R' = R + d, R = R \pm 0.85 = 5 \pm 0.85$, or the limits of the probable true ratio of concentration will vary between 5.85 an 4.15.

Now $d, E = + \frac{CT}{(C-T)H^2} \cdot d, H - \frac{C(C-H)}{H(C-T)^2} \cdot d, T - \frac{T(H-T)}{H(C-T)^2} \cdot d, C = \frac{(0.102)(0.002)}{(0.102-0.002)(0.022)^2} \cdot (-0.022) - \frac{(0.102)(0.102-0.022)}{(0.022)(0.102-0.002)^2} \cdot (0.0005) - \frac{(0.002)(0.022-0.002)}{(0.022)(0.102-0.002)^2} \cdot$

$$(0.005 = -\frac{1.02}{121} - \frac{0.204}{11} - \frac{0.01}{11} = -0.026.$$

But a complete change of signs for d, H, d, T, and d, C will give this same figure with opposite sign. Therefore $E' = E + d, E = E \mp (0.026) = 0.927 \mp (0.026)$.

That is, the limits of the probable true extraction will vary from 0.901 to 0.953, or from 90.1 to 95.3% extraction.

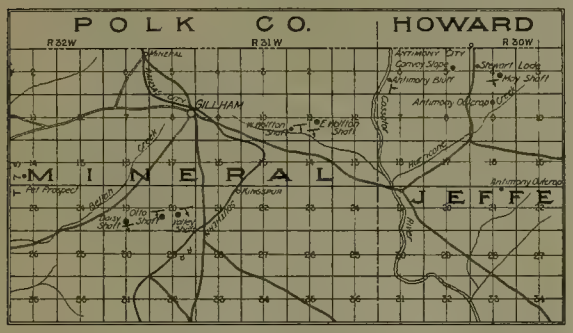
In using these formulae it must be borne in mind that the calculus only rigidly applies for minute variations, but, from a practical standpoint, they can be used even where a large error is to be analyzed. In the above case it is safe to use the calculated ratio only where variation from 4.15 to 5.85 is allowable; and in using the estimated extraction only where a variation between the limits of 90.1 and 95.3% is permissible. The larger mills are equipped with apparatus for weighing and sampling, which makes them independent of this formula; but, in a number of smaller plants, the formula is still used, and the foregoing method of study may prove valuable. To use any of the formulae for gold or silver, it is only necessary to substitute ounces instead of the decimally expressed percentages.

RICH COPPER AND GOLD ORE is reported to have been discovered in the Tchernaef district of Central Asia, with a reported richness of 20 to 60% copper. In the neighborhood of Tchimgan, 60 miles from Tashkent, Central Asia, gold deposits are reported to have been accidentally discovered.

Antimony Deposits of Arkansas

By ELLSWORTH H. SHRIVER

Antimony deposits in the State of Arkansas thus far discovered, are confined to the region adjacent to the little town of Gillham on the Kansas City Southern Railroad, in northern Sevier county. Outcrops have been discovered in an area extending about 12 miles east and west by 4 miles north and south. This area, shown

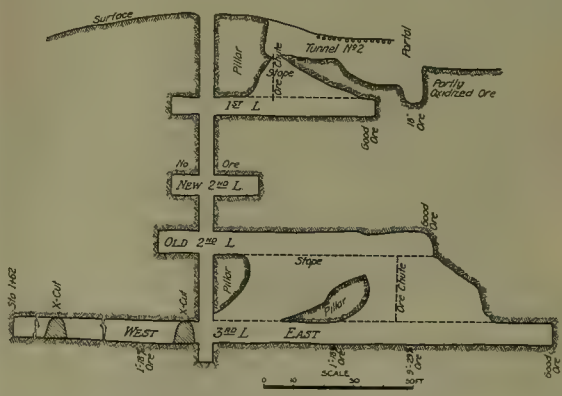


ANTIMONY DISTRICT IN ARKANSAS

in the accompanying map, consists of low hills and broad valleys. The elevation of the railroad station at Gillham is 751 ft. above sea-level. Rolling Fork river, 5 miles west and Cossatot river, 4 miles east of Gillham, drains the region, both being tributary to Little river. The country-rock of a large part of south-west Arkansas is sedimentary and is probably of Carboniferous age. The rock consists of repeating series of fine-grained, blue sandstone and argillaceous shale. The sedimentaries are supposed to have great thickness. After the sedimentation had been completed, disturbances caused flexure of the beds bending them into great anticlines and synclines. The anticlinal apexes are from a quarter of a mile to one mile apart. The disturbances were probably accompanied by great elevation of the temperature as the rigid sandstones have been bent at rather sharp angles. The shales were twisted and broken, and finally were partly metamorphosed to slates. Erosion has taken place rapidly since this action and the débris has been carried to the lower valleys as fast as formed. Some movement occurred after the mineralization was finished.

The stibnite ore was formed by replacement of the shales and slates. The folding of the sedimentaries opened passages through which ascending, hot, mineral-bearing solutions could freely circulate. The solutions broke through the underlying sandstone strata at some point and found their way through the crushed shales where the replacement occurred. Possibly some of the ore was deposited also in cavities. The fine-grained blue sandstone proved impervious to the hot waters and acted as an impounding dam. Many small beds of sandstone lying within the slate area produced parallel veins, as seen in Fig. 2. The veins in some of the mines show a banded structure. The ore occurs in the form of large lenticular masses. Quartz was deposited at the same time as the stibnite, and forms the gangue of the veins. The ore-bearing rock is the shale or slate, rarely, if ever, the sandstone. The hanging wall is decomposed slate in all cases, and the foot-wall is the fine-grained sandstone upon which the solutions flowed. The ore is cemented to the foot-wall, and varies from a thin streak to about 30 in. wide, while the full lode is from about 2 in. to 5 ft. in width. The strike of the veins is generally a few degrees north of east, and the dip is almost vertical.

Two varieties of sulphide-ore are found; one with large orthorhombic prism-structure, and another with a compact fibrous character. The fibrous ore found near the surface is generally partly oxidized to the tetroxide (cervantite) or to antimony ochre. The prismatic ore



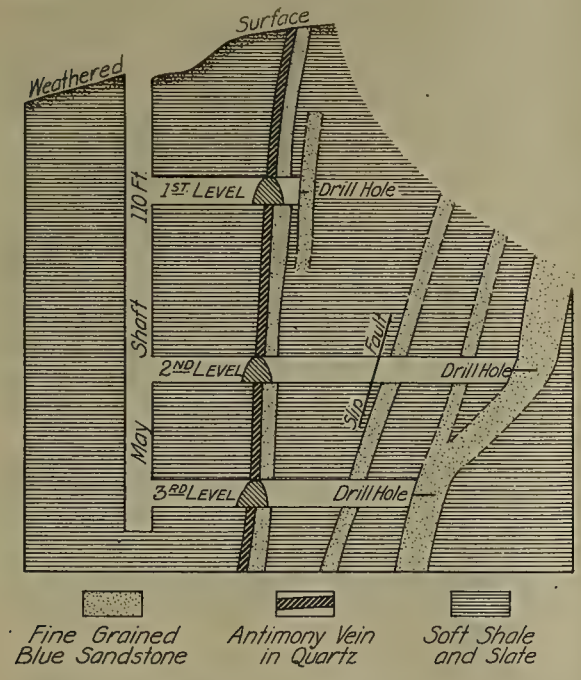
LONGITUDINAL SECTION, MAY MINE

rarely shows oxidation. A typical analysis of the high-grade, dry, sulphide-ore is given below:

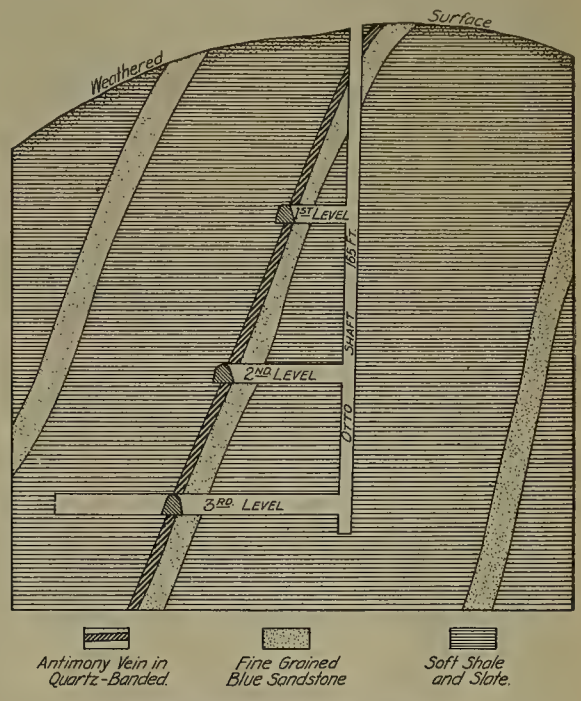
	%
Antimony	55.00
Arsenic	0.03
Lead	0.25
Iron	3.04
Silica and carbonaceous matter	11.64
Sulphur (by difference)	30.04
	100.00

The first discovery of antimony ore in Arkansas was made by Robert Wolfe, a pioneer of Sevier county, who found the outcrop of what is known as the West Wolfton mine, in 1873. A person named Batson discovered an

outcrop of stibnite and ochre, 24 in. wide, at what is known as Antimony Bluff on the east bank of Cossatot river in 1874, and the Stewart lode was discovered by Joseph Stewart in 1877. The West Wolfton deposit was worked during the summer of 1877, and in July of that year 25 tons of ore was shipped to Hallett & Co., of London. Antimony Bluff was first worked by the Little Rock Mining Co. in 1876, seven tons of high-grade stibnite and ochre being shipped to Hallett & Co. that year. A narrow vein of jamesonite was discovered near the surface in the Stewart shaft which soon pinched. This is the only known occurrence of jamesonite among the Sevier county deposits. The absence of railroads or good



TRANSVERSE SECTION THROUGH MAY MINE



TRANSVERSE SECTION THROUGH OTTO MINE

wagon roads in those days discouraged mining and nothing was done toward further exploitation for 10 years. The United States Anitmony Co., of Philadelphia, obtained control of the properties known in 1877 and started work. The May, Valley, Otto, and East Wolfton shafts were sunk by this company. A reverberatory smelting furnace was built at Antimony City, a little settlement just across the county-line in Howard county, in 1887. The smelter was not a success, although several experienced men were imported from Europe. The furnace was shut down after two months futile effort to produce a marketable metal. During the remainder of 1887 and in 1888, the United States Antimony Co. freighted ore 40 miles by wagon to Nashville on the St. Louis & Iron Mountain Railroad from which point the ore was shipped to Philadelphia, New York, and Europe. The old stopes at some of the mines, particularly the Otto, are quite large, and the orebody must have been of considerable size. Near the end of 1888, the United States Antimony Co., discouraged by want of transportation facilities and by their inability to smelt the ore, ceased operations.

Paul Knod of Gillham, worked the May mine in 1902, shipping the ore to Hill & Co., at New York. The majority of the old claims were leased by the American Antimony Co. in 1912. A small amount of work was done during the year but its capital was insufficient to continue. In 1916 the high price of antimony that had prevailed during the winter of 1915-16 stimulated interest in the Sevier county deposits. Early in January, C. M. Fenton of Joplin acquired a large number of these properties. The Valley and Wolfton claims were purchased outright, and the May and Otto were leased. A company was organized under the name of the American Star Antimony Co. with J. G. Battelle, of the Columbus Iron & Steel Co., as president, while the Otto Mining Co. was organized for the purpose of working the Otto mine, 75% of the stock being held by the American Star Antimony Co. Difficulties in obtaining machinery hindered operations and it was late in June before the mines were unwatered and ready for production. The operations of the American Star Antimony Co. aroused local interest, and several new prospects were started in the vicinity of Gillham. The Daisy Mining Co. was organized at De Queen, Arkansas, and had produced a small amount of high-grade ore when work was stopped by dissension among the owners, and the decline in the price of antimony soon discouraged the others. Construction of what was intended to be a first-class smelting plant was started in March by the American Star Antimony Co. under the direction of a Seattle metallurgical engineer. The capacity of the smelter was to be two tons of star antimony

per day. The process was similar to that of Herringschmidt, consisting of roasting the ore to the volatile oxide in muffle furnaces, condensing the oxide in chambers, and then refining it to metal. The design of the roasting-furnaces proved faulty and they were shut-down in July. An experimental electrolytic plant, with a capacity of 400 lb. of star antimony per day, was also built for the purpose of determining the possibility of recovering the antimony from the furnace residues and also for treating the low-grade ores. The capacity of this plant was later increased to 800 lb. per day.

Mechanical difficulties in the leaching system, due to the faulty design of the mill, together with metallurgical difficulties in the regeneration of the electrolyte that had not been met in the experimental laboratory work, so increased the cost of operation that it was thought advisable to close the plant until the leaching trouble could be overcome and the other metallurgical difficulties could be worked out on a laboratory scale. The results of the tests have apparently remedied the defects in the system as originally installed. The star antimony produced by the electrolytic process was of an eextremely high grade. The cathode metal, after being melted and cast into ingots, analyzed above 99.90% Sb. A typical analysis is as follows:

	%
Antimony	99.950
Arsenic	0.005
Sulphur	0.045
Iron	Trace
	100.000

After the failure of the smelting furnaces, the company made efforts to obtain an engineer familiar with antimony smelting who could design and build a furnace guaranteed to give results, but thus far these efforts have failed.

The accumulation of ore resulting from the failure of the furnaces made it advisable to close the mines on September 15. During the operations of 1916, approximately 367 tons of high-grade ore, assaying above 25% Sb, and 597 tons of 10 to 25% ore were produced. The average daily tonnage of both high and low-grade ore, from the three producing mines was about 12 tons, and the cost of mining was about $14 per ton, including haulage to the ore-house at Gillham. The American Star Antimony Co. expects to resume operation in the near future.

Gauge-Problem in Rifle-Manufacture

A statement of the present situation as regards the manufacture of both rifles and machine-guns was recently made to Congress by John Q. Tilson, of Connecticut, a member of the House Committee on Military Affairs. Mr. Tillson said that the Government had on hand at the present time approximately 800,000 Springfield service-rifles, and that the two arsenals at Springfield, Massachusetts, and Rock Island, Illinois, by working three shifts to their fullest capacity could probably manufacture 500,000 rifles per year. There are also about 350,000 Krag-Jorgensen rifles in existence, but their use is not recommended for various reasons, among them being the difference in ammunition.

To increase the output of this type of rifle by manufacture is impossible because of the lack of gauges, jigs, and other necessary tools and fixtures. A large number of these are required for making the service-rifle, which is composed of about 150 different parts. The receiver containing the bolt and the mechanism alone requires 120 gauges for its manufacture. The gauges and jigs can, of course, be made only by expert tool-makers, of whom there are a limited number in the entire country. It is estimated, if all the qualified tool-makers available should be taken off other work, and set to making gauges for the service-rifle, that it would take a year to make enough gauges to permit large-scale production of this one weapon.

On the other hand, there are now in this country, in the hands of private manufacturers, gauges and other equipment for making 15,000 per day of the Enfield rifle, which is the standard British weapon. The question of rapid production of arms then resolves itself into whether we manufacture Enfield rifles chambered for the regular ammunition used by the British army with that weapon, or whether we shall chamber these Enfield rifles for the Springfield ammunition, so that both kinds can be used.

The arsenals are also manufacturing a large number of the new service-pistol, but are not making them fast enough to equip the new officers that will be taken into the service. Both rifles and pistols have felt the high cost of living. The cost of manufacture of the Springfield rifle used to be $15 and is now $25.

Shrapnel manufacture also requires a large number of gauges. About 300 are needed for the 3-in. shell, containing 252 bullets encased in resin. It is equipped with a fuse that can be set for any time up to 21 seconds, and there is a black-powder charge at the base. The object of the gunner is to make his shrapnel explode a short distance in front of the target. The bullets then leave the shell in a fan-shaped stream, and the burning resin and powder show the gunner where the shell is exploding.

Several types of machine-guns are in service, including the Hotchkiss, Colt, Marlin, Vickers, and Lewis. The Navy has ordered 1600 Marlin guns for shooting submarine periscopes. About 300 Lewis guns were purchased last summer, and deliveries are now being made of Vickers guns. At present, the Army has only four machine-guns to each regiment, which General Leonard Wood states that we should have one gun to every ten men. While this may be too many, there is no doubt that the present number is ridiculously small.

In general, Mr. Tilson stated that the arms and ammunition now on hand would not be sufficient to equip fully an army of 100,000 men, although a large force could be equipped for drilling alone.

*Abstract from *The Iron Age*.

Physical Chemistry of Emulsions

By MARTIN H. FISCHER and MARIAN O. HOOKER

*We have been engaged during the past few months in a study of the conditions which determine the making and the breaking of emulsions. Of the long list of mutually immiscible liquids that might have been chosen for a study of emulsification, we have worked chiefly with water and oil. The mixture of two such immiscible liquids may yield two types of emulsions, as Walther Ostwald first showed; one consisting of oil in water, a second, of water in oil. With much water and little oil, the first type of emulsion is usually obtained; with much oil and little water, the second type. When medium amounts of the two liquids are mixed with each other, either type may be produced, depending upon the methods of mixing. Oil placed in contact with water does not lead spontaneously to the formation of an emulsion. To produce such, the two must be beaten together. The amount of oil that may be emulsified in pure water is very small, in no case exceeding one to two per cent. These emulsions are, however, stable. The oil-particles in such emulsions are rather small, their dimensions lying within the realm of the colloids. These low concentrations of oil in water, therefore, really represent colloid-suspensions of oil in water and possess, not only the stability characteristic of such system, but also their well-known 'saturation limit.'

The term 'emulsion' is ordinarily used to cover the subdivision of one fluid in a second in amounts exceeding these low values. The mixture must, moreover, show a fair degree of stability; in other words, the two liquids constituting the dispersoid must not separate in the course of weeks, months, or years. A temporary subdivision of any quantity of oil in a given volume of water, or the converse, can, of course, be obtained by merely beating the two together. The problem of emulsification therefore resolves itself into the question of how, once the division of oil in water has been accomplished, this can be, or is, stabilized. Contrary to the general belief of different workers who have each tried to discover some one element responsible for this stabilization, a number of different factors evidently play a rôle, the relative importance of which may not only vary in different emulsions, but in the same emulsion under different circumstances. It is generally held that the formation and the maintenance of an emulsion depend upon the slight surface-tension of the dispersing medium, and its high viscosity. While both these factors undoubtedly play a part, their inadequacy in explaining the stability of all emulsions is generally admitted. Not only does the stability of emulsions not universally parallel the surface-tension values of the liquids making up a given dispersoid, but dilute soap-solutions with low viscosity act as better emulsifying agents than more viscid glycerin-solutions. Pickering has emphasized the importance of a third factor in the maintanance of an emulsion, namely, the development of an encircling film about the droplets of the divided phase through the accumulation in the surface between the oil and the dispersion medium, of finely divided particles of a third substance. But this explanation, too, seems adequate only for selected examples of emulsions.

In reviewing the empirical instructions available for the preparation of emulsions, and in our own attempts to formulate such as would always yield permanent results, we were struck with the fact that their production is always associated with the discovery of a method whereby the water (or other medium) which is to act as the dispersing agent is all used in the formation of a colloid hydration (solvation) compound. In other words, when it is said that the addition of soap favors the formation and stabilization of a division of oil in water, it really means that soap is a hydrophilic colloid which, with water, forms a colloid-hydrate with certain physical characteristics, and that the oil is divided in this. The resulting mixture cannot, therefore, be looked upon as a subdivision of oil in water, but rather as one of oil in a hydrated colloid. The amount of colloid necessary for stabilization, at least in the preparation of an emulsion, is rather great. It must be sufficient to bind all the water. The concentrated soaps show a high degree of water-absorbing power and so are among the best emulsifying agents. Very good, too, are blood-albumin, casein, egg-white, and egg-yolk, this last already representing an emulsion of oil in a hydrated protein. Good emulsions may also be prepared, when the temperature is properly controlled, with gelatin. Not only may proteins be thus used, but various hydratable carbohydrates do well. Acacia has long been so used. Starch, dextrin(or dextrinized starches) and, when the temperature is properly regulated, agar, also serve well. Oil can also be maintained in finely subdivided form in cane-sugar solutions or in glycerin, but these emulsions slowly separate. The enumerated substances do not all act equally well. This is because, in the production of a hydrated colloid, they behave differently from both a qualitative and quantitative viewpoint. Best results are obtained with those substances which not only have the power of taking up much water, but which yield liquids of good viscosity with all amounts of water that may be added to them. What is wanted is a relatively homogeneous liquid of good tenacity, by which is meant one that possesses good covering power together with great cohesiveness. The action of casein as a stabilizing agent is particularly instructive. Neutral casein does not absorb much water, and it does not in this form serve for the preparation of an emulsion, but when alkali is added, it develops marked hydrophilic properties, on the appearance of which it becomes one of the best stabilizing agents for emulsions known. It might be thought that the alkali element is so important because it forms a soap in contact with oil, and soap has long been known as an effective emulsifier. While some such action no doubt occurs, it is easily proved that the development of hydrophilic properties by the casein is of first importance because acid (which

*Abstract: *Science*, N. S., Vol. XLIII, No. 1109, pp. 468-472.

when added to neutral casein converts it into a hydrophilic colloid) works quite as effectively as does alkali.

An emulsion breaks whenever the hydrophilic (lyophilic) colloid which holds the aqueous dispersion-means is either diluted beyond the point at which it can take up all the offered water, or is so influenced by external conditions that its original capacity for holding water is sufficiently reduced. Certain emulsions, as those of oil in soap, therefore, tend to break on simple dilution, but agents which dehydrate the hydrophilic colloid act even more rapidly and effectively. What will prove to be effective agents in this regard depend, of course, upon the character of the hydrophilic colloid that stabilizes the emulsion. When alkali-casein is used, the addition of acid breaks the emulsion, while alkali will break an emulsion stabilized by acid-casein. The same concentration of acid or alkali is without effect upon an emulsion stabilized by a carbohydrate like acacia or dextrin. Since even neutral salts will dehydrate an acid or alkali-protein, they readily serve to break emulsions stabilized by these substances. An emulsion of oil stabilized in soap is also readily broken by alcohol.

Government Copper Report

The Government has completed its report on the copper producing industry for 1916. It states that the smelter production of primary copper in the United States was 1,928,000,000 lb., compared with 1,388,000,000 lb. in 1915, an increase of 39%. The total value of the output in 1916 at an average price of 24.6c. per pound is $474,288,000, compared with $242,900,000 for 1915. In the following table the production is apportioned to the States in which the copper was mined. The total is made up of fine-copper content of blister produced and of the smelter output of ingot and anode copper from Michigan, in pounds:

	1916	1915	1914	1913
Alaska	113,823,064	70,695,286	24,985,847	23,423,070
Arizona	694,847,307	432,467,690	382,449,922	404,278,809
California	43,400,876	37,658,444	29,784,173	32,492,265
Colorado	9,536,193	7,272,178	7,316,066	9,052,104
Georgia	803,699	.....	.....	.....
Idaho	7,248,794	6,217,728	5,875,205	8,711,490
Maryland	126,965	15,426	12,248	.....
Michigan	269,794,531	238,916,410	158,009,748	155,715,286
Missouri	377,575	306,406	53,519	576,204
Montana	352,139,768	268,263,040	236,805,845	285,719,918
Nevada	100,816,724	67,757,322	60,122,904	85,209,536
New Jersey	4,115	.....	.....	.....
New Mexico	79,863,439	62,817,234	64,204,703	50,196,881
North Carolina	5,961	33,383	19,712	180
Oregon	2,433,567	797,471	5,599	77,812
Pennsylvania	904	.....	422,741	245,337
Tennessee	14,556,278	18,205,308	18,661,112	19,489,654
Texas	86,463	38,971	34,272	39,008
Utah	232,335,950	175,177,695	160,589,660	148,057,450
Vermont	324,400	23,995	.....	5,771
Virginia	1,066,143	50,008	17,753	46,961
Washington	2,473,481	903,661	683,602	732,742
Wyoming	1,784,351	351,871	17,082	262,235
Undistributed	.....	.....	65,479	51,385
Total	1,927,850,548	1,338,009,527	1,150,137,192	1,224,484,098

The total production of new refined copper in 1916 was 2,259,000,000 lb., an increase of 625,000,000 lb. from the output in 1915. The stock of copper on hand January 1, 1917, was 128,055,229 lb. as compared with 82,429,666 on January 1, 1916. The apparent consumption of refined new copper in the United States in 1916 was 1,429,755,266 lb. In 1915 it was 1,043,461,982 lb. The method employed in determining the quantity of copper retained for domestic consumption is shown in the following table, which does not include stocks of copper held by consumers:

	1916	1915	1914	1913
Total refinery output of new copper	2,259,387,315	1,634,204,448	1,533,781,394	1,615,067,782
Stock beginning of year	82,429,666	173,640,501	90,385,402	105,497,683
Total available supply	2,341,816,981	1,807,844,949	1,634,166,796	1,720,565,465
Refined copper exported	784,006,486	681,917,955	840,080,922	817,911,424
Stocks at end of year	128,055,229	82,429,666	173,640,501	90,385,402
Total withdrawn from supply	912,061,715	764,347,621	1,013,721,423	908,296,826
Apparent consumption	1,429,755,266	1,043,497,328	620,445,373	812,268,639

If to the 1,429,755,266 lb. of new refined copper is added the 594,423,807 lb. of secondary copper and copper in alloys produced during the year, it is found that a total of about 2,024,000,000 lb. of new and old copper was available for domestic consumption.

THE SUBCOMMITTEE ON ZINC, under the committee on raw materials, minerals, and metals, Council of National Defense, is as follows: Chairman, Edgar Palmer, president New Jersey Zinc Co., 55 Wall St., New York; Charles W. Baker, president American Zinc, Lead & Smelting Co., 120 Broadway, New York; A. P. Cobb, vice-president New Jersey Zinc Corp., 55 Wall St., New York; Sidney J. Jennings, vice-president United States Smelting, Refining & Mining Co., 120 Broadway, New York; Cornelius F. Kelley, vice-president Anaconda Copper Co., 42 Broadway, New York; N. Bruce MacKelvie, president Butte & Superior Copper Co., 25 Broad St., New York; Thomas F. Noon, president Illinois Zinc Co., Peru, Ill.; Charles T. Orr, president Bertha A. Mining Co., Webb City, Missouri.

MANGANESE ore imported into the United States for the first quarter of 1917 amounted to 145,720 tons, being at the rate of 48,573 tons per month, as against 48,026 tons per month for the same period in 1916.

REVIEW OF MINING

As seen at the world's great mining centres by our own correspondents.

TORONTO, ONTARIO

THE LABOR SITUATION AT PORCUPINE BECOMING WORSE AND SOME MINES HAVE BEEN OBLIGED TO CLOSE DOWN.—TEST FUME CASES DECIDED AGAINST MINING COMPANIES.—AN OFFER TO BUY OUTRIGHT THE LAND OF DAMAGED PARTIES.

Labor conditions at the Porcupine camp have been growing steadily worse, resulting in a marked falling off in production. The four-weekly statement of the Hollinger for the period ending April 22 showed gross profits of $194,688 as compared with $210,749 for the previous period, and $240,175 for the term ended December 1. The mill only ran 72.6% of possible running time. Working costs have shown a steady increase being $4.25 per ton according to the latest statement, as compared with $3.76 in December. The force now employed at the Hollinger numbers only 950 men as against 1300 at the beginning of the year. The management does not propose to make any change in the policy of maintaining operation to the fullest capacity possible. It is considered probable, however, that the Dome mines may decide on curtailing production until the labor situation shows some improvement. A party of directors went to the district last week to investigate labor conditions, and a decision on the course to be pursued is expected shortly. The annual report shows a considerable falling off in the ore reserves, which were estimated as of April 1, at 2,250,000 tons of the value of $11,979,000, as against 2,600,000 tons valued at $16,120,000 on April 1, 1916. During the year ended March 31,, 459,530 tons were treated, yielding bullion worth $2,171,784, the average yield being $4.72 per ton. Expenses were $1,241,562, leaving net earnings of $929,922. It is estimated that the decrease in ore reserves is counter-balanced by the discovery of new ore-zones and the proving up of the downward extensions of known deposits, and that the only reason why the results of development work were unsatisfactory is that it was so limited in amount. The force employed has been reduced to 375 men.

The McIntyre is now the second largest producing mine in the district. The mill is treating about 530 tons daily, and there are 400 men on the pay-roll. A statement covering the four months ended April 30 shows an operating profit of $279,563, the ore treated being of an average grade of $10.43 per ton. The ore already proved for a distance of 1000 ft. on the 1000-ft. level has been showing an average of about $14 throughout, and as the workings are being opened up into Jupiter ground the gold content is maintained. The management is arranging for the installation of machinery to carry operations 1000 ft. below the present workings. A controlling interest in the Scottish Ontario, comprising 240 acres, about one mile north of Porcupine Lake, has been purchased by a Montreal syndicate. The 10-stamp mill of the Newray is now in operation.

The Tough-Oakes, at Kirkland Lake, is treating 120 tons of ore per day, with a production of approximately $60,000 per month, employing 200 men and 21 machines. Fifty more men would be taken on if they were procurable, but under present conditions development cannot keep pace with the requirements of the mill. The Lake Shore has a large quantity of ore blocked out on the 200 and 300-ft. levels, and is receiving the machinery for its 100-ton mill. The Beaver Consolidated has made its second payment of $75,000 on the Kirkland Lake mine. The Sylvanite has closed down, owing to the shortage of labor and the high cost of materials. The Wright-Hargraves has raised funds for further development by making a new stock issue of 200,000 shares, which have been taken up at 40c. per share.

Cobalt has not been so seriously affected by labor shortage as Porcupine and the other gold camps, the pay at Cobalt being somewhat higher on account of the bonus given so long as the price of silver keeps up. Production is well maintained at present, but much uncertainty prevails as to the result of the agitation for increased wages.

An important judgment has been given in several actions for damages brought by residents of the Sudbury district against the Canadian Copper Co. and the Mond Nickel Co. for losses alleged to have been occasioned by poisonous fumes from the smelters of the companies. These cases have been before the courts for some time, and six actions were consolidated for one trial, which extended over a period of 34 days, special sittings being held at Sudbury and Toronto. Judge Middleton announced his decision on May 31, giving four of the plaintiffs damages against the Canadian Copper Co., amounting in the aggregate to $3350, and two others $1900 against the Mond Co. The application for an injunction against the companies was refused, the judge holding that though the fumes from the smelters might be a nuisance, individual rights could not be maintained against the interests of the whole community, and the court could not destroy the Sudbury mining industry, even though it destroyed a few farms. In such cases, he said, liberally estimated compensation ought to be awarded, and he had been assured that the mining companies were ready to purchase the holdings of those who suffered by their operations at a price in excess of their value. The actions were in the nature of test cases and a number of other suits which were suspended until a decision was reached will now be proceeded with.

LEADVILLE, COLORADO

MINERS DEMAND FURTHER INCREASE IN PAY.—A BI-WEEKLY PAYDAY.—A NEW AND IMPORTANT DEVELOPMENT ENTERPRISE AT CANTERBURY HILL.

The labor situation is again the centre of interest in the Leadville district as a result of the recent sitting of the State Industrial Commission here and subsequent meetings of the local branch of United Mine and Smelter Workers. The union appealed to the commission last year when the miners asked a general increase in wages of 75 cents per day. No action was taken at that time, however, and the operators voluntarily granted a total raise of 50 cents per day by making two increases during the year. This action on the part of the managers brought the wage-scale from a basis of $3 to $3.50. Early in the present year, the union amended the previous demands and asked that the commission recommend an increase in wages of $1 per day on the new basis, which would bring the scale up to $4.50.

The hearing was held in the county court room on May 21, 22, and 23, before Hiram E. Hilts, chairman of the Industrial Commission, and Commissioner A. N. Parrish. Evidence covering the local living conditions with particular reference to the increase in the cost of commodities, clothing, and rentals, and the general working conditions at the mines was secured from representatives of the union; while the operators and man-

agers testified regarding the increased cost of ore production, which, they stated, offset any increase in the value of the product.

After securing all available evidence in the matter, Commissioners Hilts and Parrish returned to Denver and conferred with their colleagues, George W. Densmore and J. A. Warren. Following ten days' deliberation on the question, the commission announced a decision opposing the demands of the union.

In a report on the situation, the commission found that living conditions at Leadville are as good as or better than in any other metal-mining district of Colorado. There has been very little increase in rentals, and although the cost of provisions has increased materially there has been only a slight increase in the cost of board. The cost of clothing was found to have increased to a small extent. Working conditions at the mines and relations between employer and employee were found to be satisfactory.

The commission also found that approximately one-half of

WOLFTONE MINE, CARBONATE HILL, LEADVILLE

the miners in the Leadville district are employed on prospecting, development, and non-productive work; and that a considerable number of the men are developing orebodies that would not be marketable under normal conditions. It was found that there has been a large increase in the market price of zinc, copper, and lead, but that the operators do not receive anything like the full benefit of the increase. Nearly all the ores now produced were reported to be comparatively low grade and the margin of profit so narrow that any material increase in the cost of production at this time would work a serious injury to the mining industry of the Leadville district.

On these grounds, the commission found the demands of the employees for an increase in wages to be unjustified, but the employers were recommended to inaugurate a semi-monthly pay-day to allow the employees to take advantage of purchasing provisions and commodities on a cash basis.

The decision of the commission is wholly unsatisfactory to the union; and rumor of forcing the issue has since kept the district in a state of uncertainty and anxiety. Two meetings of the union have been held since the decision of the commission was received, and the speakers have disclaimed any intention of striking, although they declare that some form of relief from present conditions is imperative. They ask that the operators hold a conference with union representatives and discuss the question fully. Many of the men state that any increase in wages received at this time would give only temporary relief, because they believe the prices of provisions would again be raised to a new plane that would entirely offset the gain in pay. It is this control of the merchants over food prices, they state, that should be investigated before taking other action.

The Canterbury Hill tunnel—a project that for years has been the dream of Leadville mining men—is about to be undertaken. Arthur A. Garrett, an experienced mining man of the district has secured a 20-year lease on a tract comprising 425 acres on Canterbury hill extending from the upper Arkansas valley to Little Evans gulch, including the Roseville and Alta ground, the Minneapolis, and Canterbury. Through this territory he has mapped out the course of an adit that will cut the ore-bearing formations after passing through the wash at a distance of 600 ft. from the portal, and will continue in the ore-bearing formation for a total distace of nearly 7000 ft. The elevation of the bore will be 10,100 ft.—200 ft. lower than the Yak and 1200 ft. lower than the Silver Spoon tunnel in Prospect mountain. This project will open to development an area larger than the present productive portion of the Leadville district.

The Canterbury hill area has never been developed below the blue lime, but several shafts put down from the surface encountered large bodies of iron at the contact between the gray porphyry and the blue lime. Values as high as 193 oz. silver were obtained from samples taken from the Canterbury shaft. Development in these workings was checked at the time by a heavy flow of water that resisted all efforts of draining. The adit will cut under these workings several hundred feet and will drain the entire area. The adit will at no place be more than 800 ft. below the surface and at several points it will be within 500 ft. This factor is important in that it allows for the sinking of air-shafts, and shafts for the hoisting of waste and the handling of men, that may be sunk with comparatively small expense.

The portal of the adit will be in the upper Arkansas valley about a mile and a half above the Denver & Rio Grande depot. It will follow a course through Canterbury hill swinging from east to south-east to maintain its course in the ore-bearing region.

NICARAGUA

VALUABLE MINES CLOSED BECAUSE OF INABILITY TO PROPERLY FINANCE THE PROPERTIES OWING TO THE WAR.—A VIRGIN COUNTRY UNPROSPECTED THAT AFFORDS ABUNDANT OPPORTUNITY TO ENTERPRISING CAPITAL.

The Sta. Francisca mine, formerly belonging to an English syndicate, and nearly 48 miles from the town of Leon, has been shut-down ever since the beginning of the European war, prevented by it from being re-organized. This is regrettable, as this mine, formerly a big gold producer, while in the hands of the Australian Morgan, and his associates, could still be made to yield considerable results, if worked with the proper pumping-equipment. Hot water prevented the tapping of the lower levels, which are practically unknown, except for some very rich assays obtained from the St. Luis part of the property, while under the management of J. J. Calderwood. As these hot springs are of volcanic origin and contain sulphur, the company found itself financially unable to purchase the necessary pumping-outfit and therefore had to close down. It is understood that John May, of Corinto, now owns the property.

The La Gracia mine, about five miles from San Juan de Limay, was purchased recently by the Butters Devisadero interests from Dr. Burno Mierisch and associates. This mine, which formerly was known only for its richness in silver, has also been shown to contain gold, that has been developed by Dr. Mierisch, following the suggestions of an American mining engineer who examined the property about seven years ago. The purchasers have been prevailed upon to build a cart-road which would enable them to haul their machinery from the next railway station, Leon, which is about 100 miles distant. This road, built by the mine, will prove a great benefit for the numerous farming interests of the district and to the hinterland of Segovia, as formerly all freighting had to be done on muleback. It will also help the development of the Limay mining district, which contains some valuable prospects that so far are practically untouched except for some little work done by the Castillón interests and those of General Ortiz, a

prominent miner from the neighboring Republic of Honduras. The writer of this was shown some specimens from this district that were free-milling and of unusual richness. A real prospector is an unknown quantity in this country, as the surface picking done by the natives of the country is anything but thorough prospecting.

The La Leonesa mine, near Matagalpa, which is owned by an American-English company, has been practically shutdown for the last eight months, as the main shaft was lost through the inefficiency of the pumping apparatus, and the chief value of the mine is in the lower levels now under water. The foreign staff was reduced from about 20 to 3 employees. The manager, Mr. Thomas, returned recently from a trip to London, where it is presumed he went to obtain new machinery. It is hoped that he has been successful in this, as the closing down of this property was a great blow to the district, as it was the main support of this region, apart from a few coffee ranches.

NEW SOUTH WALES

MINING INDUSTRY HAMPERED BY STRIKES, BUT PRODUCTION IS NEVERTHELESS LARGE.—TOTAL MINERAL PRODUCTION NEARLY $1,700,000,000.

In the annual report for 1916 just published the under secretary points out that the output for 1916 was worth £10,975,742, which is the third highest in the history of the State, and exceeds that of the year 1915 by £911,173. The high prices ruling for the industrial metals, notably copper, are mainly responsible for this gratifying result, and were it not for a period of industrial unrest at Broken Hill and in the Cobar field in the beginning of the year, and the coal strike towards its close, which resulted in the temporary closing down of many of the principal mines, the output would have been even more satisfactory.

The output of coal was 8,127,161 tons valued at £3,336,419 for the year 1916; a decrease of 1,321,847 tons and £88,211 in value from that recorded for the year 1915. The value for the year's production of the silver-lead mines was £4,084,623, which was £763,522 in excess of that for the year 1915.

The total aggregate value of the mineral production of New South Wales to the end of 1916 is £273,154,084. Coal heads the list with a production valued at £83,356,873, silver-lead follows with £75,328,237, and then gold with an aggregate value of £61,649,740.

The following statement of the value of the output for each decade illustrates the progress of the mineral industry during the past 50 years:

1867 to 1876	£ 18,129,455
1877 to 1886	22,422,983
1887 to 1896	46,772,464
1897 to 1906	60,772,488
1907 to 1916	100,593,702

COBALT, ONTARIO

AN APPEAL FROM AN INJUNCTION GRANTED IN THE PETERSON LAKE TAILING CASE, PENDING.—OPERATORS FAIL TO RECOGNIZE THE MINERS' UNION OF NORTHERN ONTARIO.—AN ACTIVE SEASON ANTICIPATED IN THE NEW MATACHEWAN DISTRICT.

The injunction granted to the Peterson Lake Mining Company, restraining the Dominion Reduction Company from taking tailing-slime and sand out of Peterson Lake, has been lifted, but as an appeal against the removal of the injunction has been granted, the Dominion Reduction Co. cannot yet start the treatment of this tailing. Their second flotation-unit together with grinding-equipment is about completed. The completion of this unit would enable the Dominion Reduction Co. to treat about 400 tons per day. The tailing in the lake assays between four and five ounces per ton.

An Order-in-Council has been passed by the Ontario government, relieving all claim-holders from the performance of assessment work on their claims in northern Ontario during 1917. The order does not cancel 1917 assessment work, but extends the time limit one year.——Vein No. 18, at the Chambers-Ferland mine, Cobalt, is showing up well under development.——The Beaver mine has now completed a 100-ft. raise on the vein recently found on the 1600-ft. level. The ore in the vein is good.——The La Rose mine management is contemplating re-opening its Violet mine east of the O'Brien.

A few weeks ago the Miners Union sent out their demands for an increase base wage-scale to the mine operators of northern Ontario, and asked for a conference, a reply being requested before the end of May. As far as can be learned no mine operators have conferred with the Union. Practically all the men in the Cobalt mines, with the bonuses, are receiving now as much as, and in some cases more, than the proposed Union scale, so that the action of the men employed at Cobalt is purely a move for recognition of the Union. The syndicate that purchased the Reeves-Dobie property in Gowganda a few months ago, has incorporated the Reeves-Dobie Mines Ltd. with a capital of $2,000,000. The officers, of whom Charles Ward is president, are all from Rochester, N. Y., and vicinity. The directorate and twenty of the share-holders are now visiting Gowganda. S. Christopherson, the mine-manager, is at present taking out some high-grade silver ore from an open-cut on a vein recently found.

There will be an active summer in the new Matachewan gold district, which includes part of Powell and Cairo townships. Weldy Young has a number of men at surface work on his claim, where some of the best discoveries were made last fall. Homer Sutcliffe has a party of engineers at work on an extensive water-power survey on the Montreal river near the new finds.

JOHANNESBURG, TRANSVAAL

THE STATES MINING COMMISSION REPORTS UNFAVORABLY ON STATE MINING ON THE RAND.—ENGINEERS ENDEAVOR TO SOLVE THE DIFFICULTIES OF HEAVY FLOW OF WATER IN DEEP MINES.

The majority of the States-Mining Commission have reported against the principle of the Government adding to its responsibilities that of State-mining, principally on the grounds that mining is a risky and speculative business and the Far East Rand is no exception to the rule. These views expressed by the majority of the commissioners have caused no surprise, and as the Minister of Mines, long before the appointment of the State Mining Commission was contemplated, expressed the view that the Government was not desirous of adopting State-mining, it is certain that as far as the present Government is concerned the right of future working of the Government mining-areas in the Far East Rand, will, as heretofore, be put up to Lender. There were two minority reports, one by Mr. Roos, the leader of the Nationalist party in the Transvaal, and the other by Mr. Miller of the Labor party. Mr. Roos thought that too much importance was attached to the mining risks of the proved portions of the Far East Rand, and that if the mining-houses were prepared to pay for the right of developing designated Government areas on the Far East Rand, the risks were not too great for the Government to undertake, especially as the areas belonged to the Government. He was in favor of the Government adopting a modified system of mine development on its own areas, but was not in favor of acquisition by the State of privately owned areas for mining purposes. Although not included in the reference to the Commission, Mr. Roos further advocated greater control by the

Government in working of Government-owned gold-mining areas and diamond mines, particularly over the sale of diamonds and the operation of a monopoly in the sale of South African diamonds by a private syndicate as at present. Naturally, in labor circles the recommendations of Mr. Miller, that the State should adopt mining as one of its duties, are heartily supported, but with the experience in South Africa of State-owned railways to guide them, few people outside the Labor and Socialist parties are in favor of pure and undiluted State mining.

It has been decided to try the cementation-process in the damming back of the water in the Angelo Deep part of the East Rand Proprietary Mines. It will be remembered that at a depth of 4000 ft. from the surface, fissures yielding 4,500,000 gal. of water per day were encountered and considerable difficulty was experienced in controlling the flow, even when strong dams for that purpose had been constructed. Although the cementation method of controlling water has been used for many years on the continent of Europe, and lately has been introduced with success in England, its use at the East Rand Proprietary Mines will be the first instance of its trial on the Rand, where apparently there is much scope for its employment. The mode of application at the East Rand Proprietry Mines will be to bore holes in close proximity to the water-fissures and by means of a pump to force a mixture of cement and water under pressure into these holes, the cement subsequently setting and preventing the escape of the water. In this case a pressure of at least 1000 lb. per sq. in. will be necessary with probably one part of cement to 25 parts of water. Some fissures take two tons of cement to seal off the water and the result of the experiment will be watched here with considerable interest.

CRIPPLE CREEK, COLORADO

HIGH-GRADE ORE FOUND IN SEVERAL PROPERTIES IN DIFFERENT PARTS OF THE DISTRICT.—LESSEES SUCCESSFULLY OPERATING. —OLD MINES REHABILITATED BY LESSEES.

Important and rich discoveries are reported from Raven, Ironclad, Beacon, and Tenderfoot Hill properties, owned by the Elkton Consolidated Mining & Milling Co, the Jerry Johnson Mines Co., the Gold Dollar Consolidated Mining Co., and on the privately owned Queen Bess claim, on Tenderfoot Hill.

On the Elkton property, on Raven Hill, lessees are mining and shipping ore running close to 4.5 oz. in gold per ton, from a new ore-shoot under development at the 900-ft. level. This is on the Walter vein, near to its junction with the main Elkton lode. Settlement was made last week on a 21-ton shipment at the rate of $89.20 per ton.

On the Jerry Johnson mine, L. S. Cox, a sub-lessee from Frank Caley and son, operating at the 400-ft. level, has cut the upward extension of the Caley shoot that is producing steadily from the stopes above 600 ft. The streak is 4 in. wide and assays from $800 to $1200 per ton, and that the ore as broken about 2 ft. wide will ship at 2 oz. gold, is considered a conservative estimate.

The Cripple Creek Deep Leasing Co., operating below the 600-ft. level, has entered ore under the Caley shoot at the 600-ft. level by a raise through from their 850-ft. level, and grab samples range from $27 to $43 per ton.

H. C. Harris, the Waugh Drill Company's district agent, and John Bernard, of the Elkton, leasing on the north end of the Gold Dollar company's Beacon Hill property, now operating through the Husted shaft, long idle, have cut four new veins. The hill, east of the shaft, is virgin undeveloped territory. Grab samples from the third of these veins, or rather from the shoot at the junction of the vertical with a flat vein, returned close to 3 oz. gold, with selected samples of 50 oz. or better, to the ton. This lease will commence production by the end of the week.

The Hanewald Brothers and associates, of Leadville and Denver, are responsible for the Tenderfoot Hill discovery. A new ore-shoot has been opened up by a winze 100 ft. below the 600-ft. level of the Mollie Kathleen shaft, through which the lessees are operating the Queen Bess property adjoining. Ore is being sacked for shipment that will run better than 5 oz. gold, and two cars were loaded out the first of the week of an estimated value of $40 per ton.

The new ore-shoot opened up by J. L. Wilson, of Cripple Creek, at a depth of 515 ft., by a winze sunk below the Trail-tunnel level, on Bull Hill, has been opened up 110 ft. long and the stope, which has carried up 60 ft. is producing ore from a 4-ft. vein that runs from $8 to $20 per ton without sorting.

Water has been encountered in the Dillon shaft of the Granite Gold Mining Co., on Battle mountain, at a depth of 1776 ft.,

CRESSON CONSOLIDATED MINE, CRIPPLE CREEK DISTRICT

and sinking has temporarily ceased. The deepest working-level of the Dillon is 1600 ft., and at this depth a strong ore-shoot is under development. The Granite company is making a heavy production from the Dillon and in May the output approximated 3,000 tons with an average value of $20 per ton.

The Carolina company, operating the Ajax mine adjoining the Granite Gold Mining Co., is cutting a station at a depth of 1800 ft. Sub-lessees of this company, in 12 sets, are developing their several blocks of ground, and the majority of them are producing. The Ajax properties, formerly owned by The Ajax Gold Mining Co., are now owned by E. A. Colburn, of Denver, who was president of the company.

Twenty-eight cans of concentrate was forwarded by express to the Colorado Springs mill of the Portland Gold Mining Co., last week, from the Independence and Victor mills of the company, on Battle mountain. The cans have an estimated value of from $800 to $1000 per ton, and this is the heaviest weekly shipment sent out from the local plants to date. The company is concentrating $2 ore from the ore-house waste and dumps.

The Victor mine, on Bull cliff, formerly owned by the Victor Gold Mines Co., and now by the Smith-Moffat Mines Co., of Denver, is again active. The lease held by Math Korf, of Cripple Creek, has been transferred to the Komac company, organized to operate the property. An electric-hoist and compressor have been re-fitted and are in use.

A 100-hp. electric-compressor has been installed at the Rose Nicol shaft on the north-west slope of Battle mountain by the Camp Bird Mining & Leasing Co., of which J. H. Nichols is superintendent, and the Arkansas Valley Railway Light & Power Co., has extended a power-transmission line to the mine from the Six Points transformer-station, on Bull hill. The Camp Bird company holds a six-year lease on the Rose Nicol Gold Mining Co.'s property, and development work on an extensive scale is planned.

THE MINING SUMMARY

The news of the week as told by our special correspondents and compiled from the local press.

CALIFORNIA

Amador County

(Special Correspondence.)—Four carloads of mining-timbers for the Hardenberg mine have arrived at Martell and are going to the property, where sinking the shaft is proceeding. With an increased depth of 300 ft., the future of this mine seems assured. The shaft will intersect the vein at a depth of 1500 ft., after which new levels will be opened. During former operations, the work was confined to the 850 and 1000-ft. levels, and ore-shoots of good grade were discovered but development work was hampered by lack of funds. The W. J. Loring Company is now working this mine.

After a long delay, the parts necessary to complete the Old Eureka's electrical equipment have arrived, and the new hoisting-machinery and large head-frame have been working well for over a week past. An immense amount of work has been done in bringing this old property to its present stage and there yet remains much to do before it can again become a producer, but with the modern equipment rehabilitation will proceed rapidly. The fact that the shaft from about the 1600-ft. level to the bottom was found to be single compartment, which required widening and re-timbering, has been a task of no small extent, but when finished the entire shaft will be in excellent working condition. Cleaning out and repairing old levels and getting them ready for work will also take time, but good progress is being made. The entire plant presents a business-like appearance.

Shaft-repairing is in progress at the Kennedy mine and repairs are also under way at the tailing dam, where the retaining-wall was undermined, the break having been caught up sufficiently to permit the resumption of milling after a short shut-down.

Sutter Creek, June 16.

Butte County

(Special Correspondence.)—Natomas Consolidated has acquired a large area of proved land near No. 4 dredge and is making preparations for dredging. Repairs have been made to boats No. 1 and 3. For several months the company has been carrying on experimental dredging of old tailing, and the results are reported as favorable.

A compressor and Denver drills have been installed at the Triumph mine, near Lumpkin, and development has begun. The mine workings and roads have been repaired and telephone connections will soon be made with Forbestown. It is stated considerable ore of good grade is exposed. M. B. Sears is manager.

The Springer Consolidated Mines Co. has erected equipment at its mine about one and a one-half miles from De Sabla. The plant contains a crusher and four ball-mills, having a capacity of 300 tons. The ore occurs as a huge dike about 300 ft. wide and traceable for miles, the material being low-grade. It is planned to work the deposit with steam-shovels. Charles M. Schwab and other Pittsburg men are interested.

New pumps have been installed at the Royal Drift gravel mine, near Forest Ranch, and development is progressing with three shifts. Good gravel is reported at several points. J. Allen Veatch, the manager, is expected back from Panama in a short time to resume charge of affairs. In his absence development has been directed by Forrest H. Snow.

The Oroville Dredging Co. has started the prospecting of wide areas along Bear river, in Yuba county, to determine the feasibility of dredging. Some dredging was done in the district years ago, but with varying results. With large modern boats it is thought the ground can be profitably mined. G. C. Aaronson is in charge of the prospecting crew.

Oroville, June 18.

Del Norte County

(Special Correspondence.)—The mines mentioned below are in California, though Waldo, Oregon, is the nearest post-office:

The Britten and Wilson copper mine, on Patricka creek, is in operation, and some rich ore is being taken out. There are 800 ft. of adit, and 60 ft. of shaft on the property. They are now running a 500-ft. adit to cut the vein 200 ft. below the shaft. J. N. Britten is in charge of the mine.——The Lucky Boy, a copper property 16 miles south-west of Waldo, has been under lease to Portland parties for some time, but they were unable to handle it, so a new company is examining the mine and reports a large body of high-grade ore in sight. The property is owned by Otto Anderson.

The chrome property 25 miles north-east of Crescent City, owned by G. W. Gravlin, has been leased by M. A. Delano, of Grants Pass. A noteworthy feature of this ore is its platinum content. Samples analized by the Bogardus Testing Laboratories, of Seattle, showed chromium oxide 62.08%, ferrous oxide 30.13%, sulphur 0.06%, phosphorus 0.11%, silica 5.71%, platinum 0.04 oz. per ton.

The Home gold mine, on Monkey creek, is to be re-opened under direction of J. N. Britten. It is owned by O. F. Samson, of Seattle, and has 2100 ft. of adit. There are accommodations for 40 men at the mine.

Waldo, June 16.

(Special Correspondence.)—The Tysen chrome property, 18 miles north of Crescent City, and 3½ miles from the stage-road, has 400 tons of ore ready for shipment. John Hampshire, Grants Pass, Oregon, of the American Exploration Company staff, is in charge. The ore is to be shipped by steamer to San Francisco.

Crescent City, June 14.

Mariposa County

(Special Correspondence.)—The Early mine, near Jerseydale, which has been idle for nearly a year and a half, pending the outcome of litigation, has resumed operations with 30 men. A mill is under consideration by the owners. Geo. H. Hook is superintendent.

Jerseydale, June 12.

San Benito County

(Special Correspondence.)—The district about New Idria is showing increasing activity in the development of mineral resources. The Aurora quicksilver mine has been re-opened, and 60 men are at work at the large magnesite mine five miles from here.

New Idria, June 14.

Shasta County

(Special Correspondence.)—C. L. Wilson, of San Francisco, who controls the Bell Cow group of gold mines, says of that property: it is 45 miles south-west of Redding, on the middle fork of Cottonwood creek, and on the north slope of Arbuckle mountain. The geology of the district has not been carefully studied, but the rocks generally are slate traversed by dikes of porphyry. There are 20 claims in the group, of which three are partly developed by 10 adits, each of which is driven on a

separate vein. These veins, which run north-south, are from 3 to 20 ft. wide and carry an ore that assays from $7 to $75 per ton. The sulphide mineral present is practically confined to galena and mispickel. Pyrite, chalcopyrite, and blende are thus far generally absent in the ore. The concentrate obtained in milling this ore runs from $175 to $300 per ton.

There is a system of cross-veins branching out from the main veins, at an angle of 45°, that are free from sulphides, but which do carry gold, some of the ore being high-grade. These veins are 4 to 5 ft. wide.

The principal development is a cross-cut adit, known as tunnel No. 1, now in 500 ft., that has already crossed three veins, but the adit has passed through them at points outside of the ore-shoots, and the quartz there is low grade. Drifts will be run on each of these veins. This adit will give a maximum back of 1500 ft. on the veins, and thus afford the least expensive method of mining. At present the property is equipped with a 5-stamp testing mill. Flotation tests also are to be made, as it is thought the ore will be amenable to that process, and that it can be applied with success. Another advantage at these mines is abundance of free water power, and timber sufficient for mining purposes.

Redding, June 20.

Sierra County

(Special Correspondence.)—The adit at the Orient mine is in 125 ft. and is expected to reach the orebody within 125 ft. further. At the present rate of progress the work will be completed the first week in July. The Orient formerly produced a great deal of gold and is expected to employ a large force soon.

Vigorous work is proceeding at the White Bear gravel mine, operated under bond by John Costa. In the main drift, sand and fine gravel has been entered and a winze is being sunk to bedrock. Work is proceeding on what is believed to be the east rim of the White Bear lead, where exceptionally rich gravel was found years ago by W. J. Belcher and associates.

At the Monarch Consolidated mine, at Sierra City, all work is concentrated on early completion of the main adit, being driven to open the vein. Work on the upper levels has been temporarily suspended and the mill hung up. It is planned to produce all ore in the immediate future from the new adit, and to later open the orebody by a still lower adit.

The Tightner mine at Alleghany continues to produce rich ore and to pay substantial profits. Most of the ore now going to the mill is of medium grade, but occasional pockets of rich quartz are found. It is stated that the gold output of the Tightner to date exceeds $1,500,000.

Hydraulic mining is active at Brandy City, Howland Flat, Port Wine, and other Sierra county districts. At Brandy City four to six giants are constantly operating, and abundant water indicates a long season. The mines are controlled by the Brandy City Hydraulic Mines Co. of San Francisco.

Downieville, June 19.

IDAHO

Custer County

(Special Correspondence.)—The board of directors of the Empire Copper Co. at the meeting held June 8, at Salt Lake City, declared the regular quarterly dividend of 5%, payable July 1, to stockholders of record June 25. The board also subscribed for Liberty Bonds to the amount of $50,000. The bonds will be distributed to stockholders at a later date in lieu of an extra dividend, which had been contemplated. During 1916 this company paid dividends totaling 17% on the capital stock, and thus far in 1917 has paid 20%, including the Liberty Loan investment.

Extensive exploration and development work is being carried on, under the direction of L. F. Clemmons, with satisfactory results. On June 15 a contract was let for driving a 560-ft. four-compartment vertical raise to connect the Alberta and Davis levels. Installation of a $15,000 boiler and compressor-plant at the Cossack tunnel is nearing completion, and upon the receipt of approximately 10,000 ft. of 4 and 5-in. black-pipe, work on the driving of a 1007-ft. incline-raise from the Cossack to the Alberta level will be begun. Bids have been received for the construction of a 16,300-ft. tramway to connect the mine with the smelter loading-site and the contract will no doubt be let in the near future. This tramway will do away with the expensive Shay-road operation. F. A. Behling is manager.

Mackay, June 14.

MONTANA

Lewis and Clark County

(Special Correspondence.)—Recent development in the Drumlummon mine has disclosed 7 ft. of ore in the Maskeline adit-level just south of the old No. 2 station. The average of this width is above 2 oz. gold and several ounces silver. The vein had been stoped along this orebody, which was supposed to be the hanging wall. The extent of the ore has not been determined, but development proves that it extends below the level, above it, and to the south. The mill of the St. Louis company, now operating the Drumlummon, is treating 100 tons per day, has ample ore in sight, and is developing reserves which assure extended operations.

The Gloster mill is treating 175 tons per day of which upward of 100 tons is coming from the Shannon mine, of the Barnes-King Development Co. At the latter, development is proceeding on the 500-ft. level on some of the best ore in the mine. This is gratifying to the company and reassuring to other operators in the Mt. Pleasant district.

The Marysville Gold Mining Co. continues the development on the Blue Bird and Hickey group, the Mt. Pleasant, and Spokane. Driving is proceeding in ore of good average mill-grade, and the reserves of ore developed justify the contemplation of milling facilities. At the Spokane mine of this company the raise from the upper adit has holed through to the 60-ft. level of the old shaft on the slope of the mountain. The value of the ore here ranges up to $80 per ton. This vein is in granite and seldom carries above 2 oz. of silver.

For the past year local interests have been developing the Looby and Rock Rose mines of the Cruse Consolidated company, and has reached a point at which the operators feel justified in proceeding on a more extensive scale. Efforts to finance the proposed work are meeting with success, assuring the rapid development of the mines and early shipping. The Northern Pacific railway is installing a loading-spur at the Ft. Harrison branch to facilitate shipments of ore and supplies. The Rock Rose shaft is being sunk to the 300-ft. level. As soon as this work is completed, the development of the new vein recently encountered on the 200-ft. level, and cross-cutting for the same on the 100 and 300-ft. levels will be pushed.

At the Helena mine the Helena Mining Bureau has encountered shipping ore in extending the shaft. This will enable the local syndicate to commence shipments of selected ore in a few weeks.

On the True Friend and Cross Fire claims John A. Rowand is sinking and has shipping-ore in the old incline, which he is deepening. These claims lie west of and parallel with the Helena mine, the latter apparently on the northern extension of the Looby.

A number of outcrops throughout the Grass Valley basin give promising returns on assay, but, as yet, the operators have not been in a position to give them the attention they merit. With the work more generally extended, it looks as if the district would become a producer of more than ordinary importance. The value is in gold, silver, and lead, lightly mineralized quartz veins carrying gold almost exclusively, while the silver-lead veins carry from one to four dollars in gold.

Geologically, the district is analogous to that of the mineralized area of Marysville, that is, proximity to the monzon-

lite, slates, and intersecting diorite-porphyry dikes, marking the similarity.

Helena, June 18.

NEVADA

Esmeralda County

(Special Correspondence.)—Negotiations have been practically consummated for the control of the Florence mine by the Red Hill Florence Co. Under the plan presented to majority holders of Florence stock, the Red Hill Florence owners require at least 600,000 shares, giving them undisputed control, upon which they have agreed to liquidate the indebtedness of the Florence Goldfield Co., amounting to about $50,000. The company is at present in the hands of a receiver. Culmination of the deal will be followed by extensive development of the Florence mine from the Red Hill-Florence shaft. Considerable work is going forward in Red Hill-Florence territory. On the 500 level two shifts are driving to open the Florence vein.

It is reported that as soon as the Goldfield Consolidated Co. can make arrangements for the marketing of a larger quantity of flotation-concentrate the second 500-ton flotation-unit will be operated, chiefly on ores from the Atlanta, Kewanas, Jumbo Extension, and other properties, that are now shipping to smelters, but have no market for the lower-grade gold-copper ore. It is understood some difficulty is being experienced in the marketing of flotation-concentrate.

Preparations are being made for the immediate resumption of work at the Triangle mine near Diamondfield. J. K. Turner has been retained as consulting engineer. The property adjoins the Daisy mine and yielded some rich ore when last worked. The company has been reorganized on an assessable-stock basis.

Goldfield, June 20.

Nye County

(Special Correspondence.)—A powerful electric sinking-pump has been installed in the Victor shaft of the Tonopah Extension, and construction of the auxiliary electric-power plant is proceeding rapidly. Within 30 days the management expects to resume sinking of the shaft, which is now 1759 ft. deep. Preparations are also being made for extensive development in the lower workings. The mill is crushing 2380 tons per week, with most of the ore coming from workings adjacent to No. 2 shaft.

The Tonopah Belmont Co. has declared a quarterly dividend of $187,500, payable July 2. The Shoestring vein, recently intersected north-west of the shaft on the 900-ft. level, is showing improvement. It is 20 in wide. The Mizpah-Fault vein on this level has widened to 2 ft. of fair-grade ore. The Rescue vein is 16 ft. wide at this point, and is becoming smaller. The South vein continues to show 2 ft. of good ore. The mill is treating approximately 2450 tons per week.

The discovery of the Ohio vein near the centre of the California claim of the West End has created much interest. The vein is flat and has been opened for 200 ft. It appears to be trending toward the MacNamara, with 1300 ft. along its strike still in the California. A heavy tonnage is going to the mill.

Rumor of a possible consolidation of the MacNamara and Rescue Eula companies are in circulation. Should such an arrangement be made it is probable the MacNamara mill will be operated on ore from both mines, in addition to custom ore, of which a large tonnage is available. It is also rumored that the MacNamara company will begin a search for the continuation of the Ohio vein, lately found in the adjoining West End property.

Late reports from Golddyke are to the effect that litigation over the Keystone property, also known as the War Eagle, is being adjusted, and that preparations are being made for a more vigorous development of the gold-bearing deposit. It is a lively camp, and considerable prospecting is going on. Tonopah interests have taken options on several claims.

Tonopah, June 20.

(Special Correspondence.)—The clean-up of the sluices of the Round Mountain Placer Co., for May, resulted in a recovery of $52,000, according to the statement of L. D. Gordan, general manager. There still remains in the bed-rock cuts, it is thought, an amount equal to 15 to 20% of the sluice yield. It is expected that the June clean-up will be larger than that of May, in which were many nuggets. The water supply has been sufficient thus far, and promises to hold out well for some time longer.

Round Mountain, June 16.

NEW MEXICO

Socorro County

(Special Correspondence.)—The last clean-up at the Mogollon mill amounted to 1400 lb. of bullion and 3½ tons of high-grade concentrate. The high price of silver has increased the value of dump-ores in the district to a point where they can be worked at a good profit. The Socorro Mines Co. is milling a considerable tonnage of dump-rock from the Little Charlie property and other dumps will no doubt be handled.

The Oaks Co. has a gang of men building a new road to its Central shaft. The head-frame is being remodeled and put in condition for extensive work. Ore shipments are being made daily by this company from the Maud S. mine.

The Pacific mine is now shipping 15 to 20 tons of ore daily, this being handled by aerial-tramway.

Mogollon, June 19.

OREGON

Josephine County

(Special Correspondence.)—The Queen of Bronze mine continues to ship 500 tons of copper ore monthly, working 65 men. There is a large amount of ore in sight. Roy Clark is manager. ——The Waldo copper mine is under lease to local parties. In an eight months' run last year, this mine yielded ore valued at $65,000. De Witt Van Ostrand, of Phillips, Wisconsin, and A. H. Gunnell, of Grants Pass, are interested in this property.

The Maybell, Little, and Cow Boy mines are under lease to C. E. Tucker and George Fife, who are shipping high-grade ore to the Tacoma smelter.

The Lilly copper mine, which adjoins the Waldo on the south, is under option to M. A. Delano, of Grants Pass, who is shipping high-grade ore to the Tacoma smelter, by way of Grants Pass.

Takilma, June 14.

(Special Correspondence.)—D. R. Morrison shipped the first car of ore from his Pickett creek copper mine last week. It will average 10%. The shipment went to the Tacoma smelter.

Merlin, June 16.

(Special Correspondence.)—Another clean-up at the Simmons-Logan placer mine yielded $7000 in gold and $1000 in platinum in a run of 26 days. This property is owned by Mrs. Jane Simmons, of Grants Pass, and J. T. Logan, of Waldo, and has been a dependable producer for many years. It comprises about 1500 acres and is operated by hydraulic-elevators. Water is obtained from the branches of the Illinois river. There are 25 miles of ditches and pipe-line.

Waldo, June 15.

(Special Correspondence.)—A large body of chrome ore has been opened up near Oak Flat on the Illinois river. A motor-truck road 14 miles long is to be finished by July 1 to connect the mines with the county road at Selma. R. J. Rowan is manager.

A mining deal has just been closed on the Gray Back copper mine, which is situated 13 miles east of Selma and three miles from the Oregon caves. The property is taken by the Twohy people, represented locally by John Humpshire of Grants Pass. Development is to commence at once, and will include the building of a new road six miles long. There is 700 ft. of development work on the property, all adits. The property

was sold by W. L. Babcock, the owner, for the past 16 years, he having developed the group. The price has not been made public.

Selma, June 16.

(Special Correspondence.)—The Williams chrome property on Sexton mountain, consisting of 160 acres, has been leased to George S. Barton, of Grants Pass. Arrangements have been made for a large crew of men. This property was found by J. J. Williams, of Pacific Grove, California, a short time ago when surveying timber. There is 250 tons of ore in sight. It will be hauled to Threepines for shipment.

The United Copper company's mine on Grave creek is making regular shipments of high-grade concentrate to the Tacoma smelter. Some rich sulphide ore also is being shipped. Chromite mining is a comparatively new industry in northern California and southern Oregon. Until the War, no ore was shipped from this region. This season every ton that is available finds a ready market. Buyers have been scouring the district all winter and spring.

Grants Pass, June 17.

(Special Correspondence.)—On June 9 the Williams chrome property, on Sexton mountain, consisting of 160 acres, was leased to George S. Barton, of Grants Pass. Barton has arranged for miners and will begin work at once, mining and shipping ore. The property has been owned by J. J. Williams, of Pacific Grove, California. There is now over 250 tons of ore ready, which will be hauled to Threepines for shipment. The sale of this property is but one of several recently made. Already large investments have been made in buying and developing available properties, which show extensive bodies of ore, and the operators are assured of a profitable market. During the past year the first permanent development was done on the prospects in this district, when approximately 2000 tons of the ore was shipped to Chicago and Pennsylvania. Chromite occurs in many places in this county. Some of it was used at the copper furnace at Takilma, in this district, as a refractory-lining for which it was found to be well suited.

Those who have been searching this region for minerals are surprised at the richness of the placers in platinum.

John Hampshire, of Grants Pass, the local representative of the Twohy Bros. Company, owners of the railroad and smelter in the Waldo district is at Crescent City, California, investigating the company's properties in that district. All the men available are employed on the Low Divide, and other chrome properties which they have recently purchased. Shipments will soon commence. Their new purchases on Copper creek are opening up fine, and it appears there is a large amount of high-grade ore there.

Grants Pass, June 11.

(Special Correspondence.)—The Webb copper mine seven miles south-west from Waldo has been taken over by the interests now controlling the Greenback mine. The option agrees to transfer the mine from D. L. and L. R. Webb Bros. to D. R. Robinson. The property must be continuously and vigorously developed, and the ore mined is to be sorted and shipped.

The Webb property consists of nine claims, on which 1500 ft. of development has been done. The main adit 450 ft. long cuts the main vein 390 ft. in, where it is 22 ft. wide. Driving on the vein is under way. The deal settles litigation over the ownership, which has been in progress the past two years, and prevented proper development work.

A. M. Swarthly, account director of the Oregon Bureau of Mines and Geology, spent three days in the Waldo district in the interest of a series of experiments being conducted by the bureau in conjunction with the Federal Bureau of Mines, the object being to find a commercial practicable method whereby the pyrrohtite can be separated from the chalcopyrite in the ore. A satisfactory solution of this problem would be of great value to the southern Oregon mines.

The Logan placer mine, situated near Kirby, shipped to the mint last week five gold bricks, valued at $7000, the clean-up from the run of 26 days. Along with the shipment was platinum to the value of $1000, which was included in the clean-up. The experts who have recently visited in southern Oregon have found nothing that interested them more than the platinum found in almost all the placer deposits. There is little doubt that from the early days of placer mining in this region, a great deal of platinum went through the sluices.

Grants Pass, June 1.

SOUTH DAKOTA

Lawrence County

(Special Correspondence.)—The Trojan, Mogul, and Golden Reward mining companies, in the Bald Mountain district, have given their miners an increase of 50c. per day, for shift of eight hours. Wages now are: Miners, $4, shovelers, $3.50. The increase affects about 300 men about the mines.——Work underground at the Ora Honda has been discontinued, while awaiting the arrival of a new hoisting-engine.

Lead, June 16.

TEXAS

Brazoria County

(Special Correspondence.)—The first unit of a chemical-plant that will represent when completed a total investment of about $450,000, has just been finished and placed in operation here by the Freeport Chemical company, a subsidiary of the Stauffer Chemical company, of San Francisco, California. The new industry is devoted to the manufacture of sulphuric-acid and other chemical products.

In order to meet the increasing demand for sulphur and its products the output of the large sulphur mines here is being increased. It is stated that the United States used last year approximately 900,000 tons of sulphur as compared with 300,000 tons the year before the outbreak of the War. It is expected that the demand of this country will reach more than 1,000,000 tons during the present year and that it will increase to 1,600,000 tons within another year, if the present war continues. The sulphur deposits of Texas and Louisiana are almost the sole source of supply. The mines here are situated adjacent to the Brazos river and near the mouth of that stream. Deep-water channel of 18 ft. is available for vessels, but it is found that the smaller vessels are insufficient to meet the shipping demands and it is now proposed to deepen the channel to 25 ft. at an estimated cost of $455,000.

Freeport, June 8.

Llano County

(Special Correspondence.)—Considerable molybdenite is being shipped from here to Orilla, Ontario, Canada, where it is concentrated and shipped to England. The ore comes principally from the mine near here that is owned by N. J. Badu and associates, of Llano. More than 2000 tons have been shipped.

Llano, June 14.

WASHINGTON

Ferry County

(Special Correspondence.)—The Knob Hill Co. has finished grading and is sinking its new shaft, over which a head-frame is being built. At a depth of 100 ft. a cross-cut will be driven to the main vein 700 ft. below the cropping. This is 100 ft. deeper than the lowest workings. The gasoline-hoist, at present in use, will be replaced by more powerful machinery. After paying a dividend of $10,000, a reserve of $27,000 is left; 18 cars of ore are at the smelter, and several more cars are being loaded for shipment.——In the Lone Pine mine, the Day Brothers are sinking the main working-shaft by contract 250 ft. deeper, and will let a contract for driving 500 ft. on the vein. The ore is going to the smelters under contract at the rate of 100 tons daily.——E. J. Delbridge, lessee of the Tom Thumb mine, owned by the Midget Co., is employing five men in ex-

tending a 100-ft. adit to reach the Rebate vein, now owned by the Midget Co.——The Ben Hur mine has been leased to J. A. Wiseman and Thomas Gardiner.——The Belcher mine, in Belcher district, has sent 1600 tons of ore to the Granby smelter at Grand Forks, B. C., being a part of a contract for the delivery of 5000 tons. The smelter is closed down at present, on account of the coke-shortage.——J. E. Lancaster has shipped 50 tons of ore from the Boston and New York groups, near Curlew. The ore contains 10 to 12% lead and 5 to 8% copper, with 25 to 30 oz. silver per ton.

The Virginia Mining Co., operating near Danville, has installed a crude-oil engine and compressor on the Lucille Dreyfus mine, and is making regular shipments of gold and silver ore.

Republic, June 12.

CANADA

British Columbia

The Hedley Gold Mining Co. (Nickel Plate mine) has declared a quarterly dividend of 3%, and an extra dividend of 2% on the outstanding capital stock of the company, payable June 30, to stockholders of record June 23.

New Brunswick

The copper mines at Dorchester which were re-opened several months ago after 16 years of idleness, says the Daily Metal *Reporter*, have made the first shipment of concentrate, consisting of 30 tons, estimated to contain 30% copper and about 15 oz. silver to the ton. Fortnightly shipments are expected hereafter. The company is an American concern, with offices in Boston. The method of mining the ore is by chamber work. The copper is found in veins with a 20° pitch. At present the exposed face of ore is 12 ft. high and from 200 to 300 ft. long.

MEXICO

Sonora

(Special Correspondence.)—The only mine working in the Alamos district, in Sonora, at the present time is La Cacharamba, eight miles west of the city of Alamos, in the famous Quintero-Promontorio silver belt. This mine belongs to the Plata-fina Mining & Development Co., of which E. G. Swayze is president, and T. B. Brinegar general manager. Mr. Swayze affirms that development work during the revolution has put into sight 15,000 tons of ore in this mine, having an average assay value of $30 in silver. The same company is developing two new mines, and has in all six ore-shoots opened up. The branch of the Southern Pacific railroad from Navajoa to Alamos has been abandoned for several years, and shipping is carried on by wagons from depots established at Navajoa. There are rumors that an American syndicate has taken an option upon the Quintero, but we understand that this is denied by the house of Robinson Bours. The Tónichi branch of the Southern Pacific has also been abandoned for a long period, and will require the expenditure of a great deal of money to put it into working order. All mining operations along the line of that road are dead, but the manager of the La Dura mines recently outfitted at Alamos and went across country to La Dura to look over the ground, with a view to resumption of development work. The Anita mines, belonging to the Pacific Smelting & Mining Co., a New York corporation, are also closed. For a time they were shipping high-grade copper ore to the El Paso smelter. Exchange at Alamos is now on the basis of ₱1.70 for $1, but at Nogales, on the border, exchange has reverted to the pre-revolutionary rate of ₱2 for $1. Mining development in Sonora is at a standstill.

Alamos, June 14.

KOREA

The Seoul Mining Co., operating the Suan concession, in Whang Hai province, reports for the month of May a total recovery of $153,527.

Personal

Note: The Editor invites members of the profession to send particulars of their work and appointments. This information is interesting to our readers.

Henry Hanson has gone to Peru.

George O. Scarfe is at Le Pas, Manitoba.

Charles Janin has returned from Russia.

Charles R. Fettke is examining oil-lands in Kentucky.

Kenneth J. Hlebnikoff is returning to Harbin, in Manchuria.

H. Vincent Wallace expects to go shortly to Guanajuato, Mexico.

H. Abey is returning to Japan on the 'Tenyo Maru,' sailing on June 30.

Mark R. Lamb is now occupied in the export business at New York.

M. W. von Bernewitz is examining ancient gravel channels near La Port, California.

F. H. Minard passed through San Francisco on his way from New York to Medford, Oregon.

W. M. Brewer has been appointed resident engineer for the Western district of British Columbia.

C. Gore-Langton is engineer for the Great Western Electro-Chemical Co., at Pittsburg, California.

Robert H. Chapman has left Washington to perform military duties at Tobyhanna, Pennsylvania.

S. C. Dickinson has been appointed safety engineer for the Arizona State Bureau of Mines at Tucson.

W. B. Blyth and F. A. Marriott have entered into an engineering partnership in Bulawayo, Rhodesia.

E. Michot and X. Pichon, of the Boleo Copper Co., passed through San Francisco on their way to New York.

Frank C. Laurie has been appointed superintendent for the Freeport & Tampico Oil Corporation, at Tampico, Mexico.

V. F. Marsters and Chas. N. Gould have opened a consulting geological engineering office at 316 Rialto building, Kansas City, Missouri.

F. O. Jasmer has just returned from an extended trip through the central and western part of Mexico, and is leaving for New York about July 1.

Charles E. Prior has resigned his position as chief engineer with the La Blanca mine, at Pachuca, Mexico, in order to volunteer for military service.

W. S. Noyes, who has been the victim of legal persecution for three years, was acquitted on June 20, the judge instructing the jury to bring in a verdict of not guilty, holding that no case had been made.

The Walter A. Zelnicker Supply Co., of St. Louis, announces the appointment of Karl W. Bock as manager. Mr. Bock was, for the last ten years, secretary of and assistant to the vice-president of the Union Pacific Coal Co. and subsidiary coal companies at Omaha.

E. F. Burchard has been appointed chief of the new section of the United States Geological Survey to cover geologic investigations of the ores from which are derived the alloy metals used in making special steels. G. F. Loughlin will assist Mr. Burchard in the non-metallic section of the division of mineral resources.

The address by Robert C. Sticht before the San Francisco section of the A. I. M. E. will be delivered on July 17, not July 10, as first announced. The meeting will be at the Engineers Club at 8 p.m., preceded by the usual dinner at 6:30. The subject is 'Pyrite Smelting,' a branch of metallurgy in which Mr. Sticht has so greatly distinguished himself.

Victor Viderton, a mining engineer, of Globe, Arizona, died at San Francisco, June 25, at the age of 60 years.

Eastern Metal Market

New York, June 20.

Nearly every metal in the metal-market still hangs fire awaiting the action of the Government. This is getting to be an old story and is wearing on the nerves of many who are interested in this branch of trade.

Copper continues firm but more or less dull.

Lead is quiet and a little easier.

Tin is dull but higher on the uncertainty of the London market, due to absence of cables.

Antimony is again lower with demand very light.

Interest in the steel market centres in the continued advance in steel prices with no signs of control. Many producers have ceased selling despite high offers from eager and anxious consumers, while others have refused to advance prices, as in the case of the leading wire interests, but the intended effect has not resulted. The world-wide famine in plates which has sent prices up twice as far as those of other steel-products sold in the same level, coupled with the need of the Government for more plates for ship-building than for anything else, has mixed up the price-fixing problem. Manufacturing consumers are trying harder than ever to get protection on finished steel for 1918, but with little success so far. The pig-iron market is quieter.

COPPER

The market continues a waiting one—the same old story—waiting for some action by the Government and its Allies regarding the quantity and the price of the copper to be needed. No definite trend in the market, up or down, is expected until this matter is settled. Conditions remain practically unchanged. If anything, the market is a little easier, but it is still firm and strong. Sales of small volume are being continuously made for all positions but there is no large demand. Metal desired this side of August is obtainable only from small producers or second hands with early delivery quoted about nominal at 32.50c., New York. The quotation for third quarter, outside of July, is 30.50 to 31c., New York, with fourth quarter at 29 to 29.50. July metal is generally pegged at 31.50 to 32c. It is persistently rumored and confirmed in some quarters that the Government is now having copper delivered for its use at 28c. per lb., though it is stated that this is not a definite settling price but merely one selected for billing purposes, the real price to be paid to be decided upon later. Absence of exact information is a very unsettling factor. The status of the London market is not known in the absence of cables so far this week. At last advices prices were unchanged there from those quoted a week ago in this report.

TIN

It is unusual for cables to the New York Metal Exchange to be lacking for two days, but so far this week none have come from London. This has caused considerable unsettlement and confusion in the trade. No satisfactory explanation is offered. Private advices by cable to a couple of firms reveal a decided advance in the London tin market, exceeding £8 per ton. As a result of this, prices were marked up on Monday and Tuesday here nearly 3c. per lb. above those at the end of the previous week. Yesterday the more or less nominal price was 63.50c., New York, with the price for Monday at 64c. On Wednesday, Thursday, and Friday last week the quotations, based on sales, were 60.75c., 61.25c., and 61.75c., New York. The absence of cables has caused a temporary halt in the market with sellers restless and buyers shy and with naturally a disinclination to commitments on either side. A fair volume of business was done last week in a quiet way in future shipments from the East. On June 13 August shipment from the East sold at 54.75c., with September at 54.62½c. On the 14th August and September shipment went at 55.66¾c., and on the 15th, September shipment commanded 56.25c. On June 14 there were fair sales of spot tin at 61.25c., New York. Tin arrivals up to and including June 19 were 1095 tons, with the quantity afloat at 3156 tons. Banca tin is about 3c. under the regular prices.

LEAD

It is confidently believed that some definite understanding has been reached between the Government and the lead interests as a result of the meetings last week. While the actual quantity to be needed is understood to be still in abeyance, the price agreed upon, while not officially announced, is stated to be 8c. per lb. or about 4c. under the present market and about double normal prices. It is also generally reported that the quantity to be needed does not come up to the expectations of many up to this time. That these reports are more or less true is partly borne out by the fact that large producers who have been consistently refusing to sell so as to take care of large Government needs, are now offering some metal and by the fact that the price is declining. Yesterday the New York quotation was 11.75c. with 11.50c. as the St. Louis figure. The entire market is very much quieter than for some time and there has been a considerable falling off in sales. It is difficult to forecast the future, but continued high prices are looked for by many. The American Smelting & Refining Co. still quotes 11c., New York.

ZINC

With demand at a standstill and with large dealers or producers firm in their position, quotations continue more or less nominal. Prompt June metal may be regarded as a little easier perhaps at 9.67c., New York, but futures continue firm at 9.75c., New York, or 9.50c., St. Louis. The ore market continues its sustaining influence, for while ores are high, the metal itself cannot be expected to recede much. The belief persists also that business inside of a few weeks will take on more activity, and this sentiment tends to strengthen the market. Until something definite is known as to the Government's requirements, continued inactivity is expected.

ANTIMONY

In the absence of active demand the quotation for nearby metal contitnues to recede and Chinese and Japanese grades are quoted at 19 to 20c., New York, duty paid. There is more interest in futures and some good sales are reported.

ALUMINUM

The president of the Aluminum Company of America, Arthur V. Davis, announces that his company has offered to meet the Government's requirements for aluminum at 27.50c. per lb., this figure having been arrived at by adding 2c. per lb. to the average for the last 10 years. No. 1 virgin metal, 98 to 99% pure, is quoted at 59 to 61c., New York, with demand of small proportions.

ORES

TUNGSTEN: Quotations are unchanged at $20 to $22 per unit for 60% concentrates, but it is reported that the demand is greater than the supply. Canada is again in the market. Ferro-tungsten is quoted at $2.25 to $2.50 per lb. of contained tungsten.

ANTIMONY: There is no change in the quotation which continues firm at $2.30 per unit.

MOLYBDENUM: Not much ore is being offered and prices remain firm at the unchanged quotation of $2.10 to $2.20 per lb. of MoS_2.

THE METAL MARKET

METAL PRICES

San Francisco, June 26

Antimony, cents per pound	19.50—22.00
Electrolytic copper, cents per pound	32.50
Pig lead, cents per pound	12.25—12.50
Platinum, soft and hard metal, per ounce	$105—111
Quicksilver, per flask of 75 lb	$80
Spelter, cents per pound	11.50
Tin, cents per pound	59
Zinc-dust, cents per pound	20

ORE PRICES

San Francisco, June 26

Aluminum-dust (100-lb. lots), per lb	$1.00
Aluminum-dust (ton lots), per lb	$0.95
Antimony, 50% metal, per unit	$1.45
Chrome, 40% and over, f.o b. cars California, cents per unit	50—55
Magnesite, crude, per ton	$8.00—12.00
Tin, cents per pound	60
Tungsten, 60% WO_3, per unit	20.00
Molybdenite, per unit for MoS_2 contained	40.00
Manganese, 45% (under 35% metal not desired), cents, unit	36—38

Manganese prices and specifications, as per the quotations of the Carnegie Steel Co. schedule of prices per ton of 2240 lb. for domestic manganese ore delivered, freight prepaid, at Pittsburg, Pa., or Chicago, Ill. For ore containing

	Per unit
Above 49% metallic manganese	$1.00
46 to 49% metallic manganese	0.98
43 to 46% metallic manganese	0.95
40 to 43% metallic manganese	0.90

Prices are based on ore containing not more than 8% silica nor more than 0.2% phosphorus, and are subject to deductions as follows: (1) for each 1% in excess of 8% silica, a deduction of 15c. per ton, fractions in proportion; (2) for each 0.02% in excess of 0.2% phosphorus, a deduction of 2c. per unit of manganese per ton, fractions in proportion; (3) ore containing less than 40% manganese, or more than 12% silica, or 0.225% phosphorus, subject to acceptance or refusal at buyer's option; settlements based on analysis of sample dried at 212° F., the percentage of moisture in the sample as taken to be deducted from the weight. Prices are subject to change without notice unless specially agreed upon.

EASTERN METAL MARKET

(By wire from New York)

June 26.—Copper is inactive and nominal at 32.50 to 32.25c. Lead remains quiet at 11.75c. Zinc is dull and easier at 9.50 to 9.37c. Platinum remains unchanged at $105 for soft and $111 for hard.

The quantity of platinum in the United States is estimated by the United States Geological Survey at 1,000,000 troy ounces, besides which there is over 400,000 oz. of other metals of the platinum group, principally palladium, iridium, and rhodium. In 1916 the crude platinum mined in Colombia (25,000 oz.) was refined in the United States, and 28,088 oz. of metals of the platinum group was recovered by American refiners from all sources, foreign and domestic, of which 24,518 oz. was platinum.

It is estimated that 30,000 oz. of crude platinum, containing 85% metal, will be produced in Colombia in 1917, and that the production of Russia and the United States will be considerably increased.

COPPER

Prices of electrolytic in New York, in cents per pound.

Date		Average week ending	
June 20	32.50	May 15	32.00
" 21	32.50	" 22	32.25
" 22	32.50	" 29	32.50
" 23	32.50	June 5	32.62
" 24 Sunday		" 12	32.75
" 25	32.25	" 19	32.58
" 26	32.25	" 26	32.42

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	13.60	24.30	29.53	July	19.09	25.66	....
Feb.	14.38	26.62	34.57	Aug.	17.27	27.03	....
Mch.	14.80	26.65	36.00	Sept.	17.69	28.28	....
Apr.	16.64	28.02	33.16	Oct.	17.90	28.50	....
May	18.71	29.02	31.69	Nov.	18.88	31.95	....
June	19.75	27.47	32.81	Dec.	20.67	32.89	....

SILVER

Below are given the average New York quotations, in cents per ounce, of fine silver.

Date		Average week ending	
June 20	77.87	May 15	74.69
" 21	77.87	" 22	74.78
" 22	78.00	" 29	74.62
" 23	78.50	June 5	74.80
" 24 Sunday		" 12	75.83
" 25	78.50	" 19	77.00
" 26	78.00	" 26	78.12

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	48.85	56.76	75.14	July	47.52	63.06	....
Feb.	48.45	56.74	77.54	Aug.	47.11	66.07	....
Mch.	50.61	57.89	74.13	Sept.	48.77	68.51	....
Apr.	50.25	64.37	72.51	Oct.	49.40	67.86	....
May	49.87	74.27	74.61	Nov.	51.88	71.60	....
June	49.03	65.04	76.44	Dec.	55.34	75.70	....

According to the manager's report at the recent annual meeting of the Hongkong & Shanghai Banking Corporation, it is the coinage demands of the belligerent countries, including the expenditure on military operations in Egypt, East Africa, and Mesopotamia, that have been a contributing cause to the remarkable rise in the price of silver. "But the rise was chiefly due to the purchases made by the Indian government, who bought during the course of the past 12 months some £15,000,000 worth of silver. The balances in the Indian currency reserves were reduced by 16 crores between August 1915 and March 1916, and had to be replenished by large purchases of the metal, the urgency of which has been in no way diminished by the heavy withdrawal of rupees which is still going on.

"These demands of the Allied governments for coinage, and of the Indian government to replace the enormous absorption of silver rupees by the natives of India, where gold was not available for hoarding purposes, have more than kept pace with supplies. Outside sources of supply were tapped; the equivalent of 8,350,000 standard ounces was obtained from the Government of the Philippines in the form of peso coins, and the movement of silver funds into gold securities necessitated a heavy export of silver from China. There is no escape from the conclusion that the amount of silver left in China must be barely sufficient for trade requirements, and assuming, as we have every reason to, that there will continue to be a strong demand for the products of China, it would appear inevitable that China must again be a competitor in the silver market."

LEAD

Lead is quoted in cents per pound, New York delivery.

Date		Average week ending	
June 20	11.75	May 15	10.49
" 21	11.75	" 22	10.50
" 22	11.75	" 29	10.93
" 23	11.75	June 5	11.46
" 24 Sunday		" 12	11.83
" 25	11.75	" 19	12.00
" 26	11.75	" 26	11.75

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	3.73	5.95	7.64	July	5.59	6.40	....
Feb.	3.83	6.23	9.01	Aug.	4.67	6.28	....
Mch.	4.04	7.26	10.07	Sept.	4.62	6.86	....
Apr.	4.21	7.70	9.38	Oct.	4.62	7.02	....
May	4.24	7.38	10.29	Nov.	5.15	7.07	....
June	5.75	6.88	11.76	Dec.	5.34	7.55	....

ZINC

Zinc is quoted as spelter, standard Western brands, New York delivery, in cents per pound

Date		Average week ending	
June 20	9.50	May 15	9.37
" 21	9.50	" 22	9.37
" 22	9.50	" 29	9.50
" 23	9.37	June 5	9.66
" 24 Sunday		" 12	9.75
" 25	9.37	" 19	9.72
" 26	9.37	" 26	9.43

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	6.30	18.21	9.75	July	20.54	9.90	....
Feb.	6.95	19.99	10.45	Aug.	14.17	9.03	....
Mch.	8.40	18.40	10.78	Sept.	14.14	9.18	....
Apr.	9.78	18.62	10.20	Oct.	14.05	9.92	....
May	17.03	16.01	9.41	Nov.	17.20	11.81	....
June	22.20	12.85	9.43	Dec.	16.75	11.26	....

QUICKSILVER

The primary market for quicksilver is San Francisco, California being the largest producer. The price is fixed in the open market, according to quantity. Prices, in dollars per flask of 75 pounds:

Week ending			
May 29	95.00	June 12	90.00
June 5	90.00	" 19	82.00
		" 26	80.00

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	61.90	222.00	81.00	July	95.00	81.20	....
Feb.	60.00	295.00	126.25	Aug.	93.75	74.50	....
Mch.	78.00	219.00	113.75	Sept.	91.00	75.00	....
Apr.	77.50	141.60	114.50	Oct.	92.90	78.20	....
May	75.00	90.00	104.00	Nov.	101.50	79.50	....
June	90.00	74.70	85.50	Dec.	123.00	80.00	....

TIN

Prices in New York, in cents per pound.

Monthly Averages

	1915	1916	1917		1915	1916	1917
Jan.	34.40	41.76	44.10	July	37.38	38.37	....
Feb.	37.23	42.60	51.47	Aug.	34.37	38.88	....
Mch.	48.76	50.50	54.27	Sept.	33.12	36.66	....
Apr.	48.25	51.49	55.63	Oct.	33.00	41.10	....
May	39.28	49.10	63.21	Nov.	39.50	44.12	....
June	40.26	42.07	....	Dec.	38.71	42.55	....

The tin market is still upset, due to the non-receipt of cables from London. A slight advance is expected in London, but the present home market is quoted nominally at 63c. with Banca and Chinese tin at a marked discount.

TUNGSTEN

There is still more demand than supplies, and on top of the home demand, Canada has again come into the market, especially for scheelite. The market is quoted $20 to $22 for high-grade material.

MOLYBDENUM

Molybdenum remains unchanged and firm with prices varying from $2.10 to $2.20 per pound MoS_2 with very little material offered.

ANTIMONY

Antimony has been active during the past week and prices for spot range from 19½ to 19¾c. Needle antimony is still firm at 12c. for spot, with futures quoted at 9½c. Antimony ore remains firm at $2.30 per unit.

MANGANESE

The demand for manganese continues and $1 per unit has been paid for high-grade furnace-ore during the last week f.o.b. New York. Chemical-ore prices are practically the same.

Book Reviews

STRESSES IN STRUCTURAL STEEL ANGLES, with Special Tables. By L. A. Waterbury, C.E. Pp. 77. John Wiley & Sons, Inc., New York, 1917. For sale by MINING AND SCIENTIFIC PRESS. Price, $1.25.

The text in this handy little volume is limited to 27 pages; it is intended merely to present the fundamentals of theory for ready reference in the use of the tables which the author has calculated, and which constitute the great value of the work for the engineer. These tables present the data for all conventional structural sizes of steel shapes in common use, relating to the following: elements of angles with equal legs; elements of angles with unequal legs; co-ordinate of section modulus polygons for angles; efficiency and allowable tension for angles riveted through one leg to a rigid connection-plate, when two holes for $\frac{7}{8}$ in. rivets are deducted from the connected leg; and efficiency and allowable tension for angles riveted through one leg to a rigid connection-plate, when one hole for $\frac{7}{8}$ in. rivet is deducted from the connected leg. The author presents the development of formulæ for the relation between bending-moment and flexural stress; section modulus; product of inertia; section modulus polygons; neutral axis; plane of loading; combined stresses; flexure for angles in pairs; transfer of stress by shear to an outstanding leg; and efficiency of end-connections. The latter is discussed in relation to a large number of values of efficiency, of equivalent effective area, and of total permissible tension, for a maximum unit-stress of 16,000 lb. per sq. in., computed in accord with the method developed in the text. The book is characterized by a practical, clean-cut discussion, and by a systematic, well-arranged set of tables, all which should commend it as a valuable office-assistant to the designer of steel structures.

STEAM TURBINES. By James Ambrose Moyer. Third Edition. Pp. 460 and index. Ill. John Wiley & Sons, New York and London. For sale by the MINING AND SCIENTIFIC PRESS. Price, $3.50.

This excellent work is a compendium for power users, being a practical and theoretical treatise for engineers and students. It reviews completely the recent improvements in the economy of steam-turbines, and as the author says, "The low cost of power where fuel is cheap makes the large turbine-electric generating-plant almost an unrivaled competitor of water-power for metallurgical purposes. Many changes have been made in some departments of the book and it is in every sense up-to-date. All who contemplate large power installations should secure this book in order to be fully informed in the most modern practice in the generation of power for any purpose whatsoever. In an appendix is a series of questions for the student who soon may have these very questions presented to him in actual practice.

OXY-ACETYLENE WELDING PRACTICE. A Practical Presentation of the Modern Processes of Welding, Cutting, and Lead-Burning, with Special Attention to Welding-Technique for Steel, Cast-Iron, Aluminum, Copper, and Brass. By Robert J. Kehl, M.E., Ill.; index; .pp. 102. American Technical Society, Chicago, 1917. For sale by MINING AND SCIENTIFIC PRESS. Price, $1.

The author states succinctly that the advantages of the oxy-acetylene over the oxy-hydrogen process for welding consists in the easy control of the heat developed by the flame, which is approximately 6300° F, and in the abundant supplies of carbide and dissolved acetylene that are available in every industrial centre in the United States, as well as in the cheapness of the apparatus required and the low cost of operation. No automobile repair-shop today can dispense with this handy equipment, and no mine or metallurgical works of any size should be without it. The more remote from the railroad or the city the greater is the need of it ready at hand to meet every emergency. The acetylene generator and the cylinder of oxygen cost little compared with delays, and with the annoyances of imperfect repair-work attempted with the forge and other devices. This little treatise tells the whole story of the use of the equipment and the range of applicability. The author describes with the aid of a multitude of photographs and diagrams the entire technique, so that it becomes a guide-book from which one might teach himself the art. It is a manual of procedure that should be welcome in every shop. He also explains blow-pipe cutting of metals with oxygen, and lead-burning, not the sort that is required for lining vats with sheet-lead nor for autogenous welding of large sheets as practised in the construction of sulphuric-acid chambers, but the small jobs that come up in automobile repairing, and in fixing lead-pipe and other connections where acids are handled in a metallurgical works. The discussion of oxy-acetylene welding of copper, brass, and bronze, will also be appreciated.

PRELIMINARY MATHEMATICS. By Prof. F. E. Austin. Pp. 169; index. Published by the author, Hanover, N. H., 1917. For sale by the MINING AND SCIENTIFIC PRESS. Price, $1.25.

Professor Austin has a knack for stripping off the non-essential and non-elucidative in writing text-books. In this tiny volume is compressed a full course in algebra required for entrance examinations to any first-class college. Like his 'Examples in Magnetism,' and his little books on 'High Pressure and Low-Pressure Transformers,' this little algebra covers the field as to its essentials, and in a form of statement that is lucid, even if at times he commits the mathematician's common error of leaping a fence and leaving the student struggling to see how he got over it. Sometimes, we think he employs a mathematician's statement of a problem, clear and correct enough but not in the order of thought natural to the untrained mind. It is a question of opinion, but we think that a child, undertaking to ascertain when the ages of father and son, now respectively 33 and 12, stood in the ratio of 4 to 1, would not have stated his problem in the terms $33-X=4(12-X)$; we believe the child-mind would have used the 4 as a divisor of the first term of the equation. As a self-teacher we believe the book to be a trifle too economical of explanation, but as a base to teach from we recommend it as peculiarly satisfactory.

HANDBOOK OF CHEMISTRY AND PHYSICS: A Ready-Reference Pocket Book of Chemical and Physical Data. 5th Ed. Pp. 410; index. The Chemical Rubber Co., Cleveland, Ohio, 1917. For sale by the MINING AND SCIENTIFIC PRESS. Price, $2.

This *vade mecum*, truly of pocket-size, and packed with data of chemical and physical constants, has been brought up to date by compilation from accepted first-hand sources of information. One of the most useful tabulations in the book relates to the physical constants of the elements, and of inorganic and organic compounds. As an illustration of the scope of the tables we may note that, for the inorganic compounds, the table gives the name, formula, molecular weight, crystalline form and color, specific gravity, melting point, boiling point, and solubilities in water (cold and hot) and in alcohol, acids, and alkalies. There is also a table of gravimetric factors and logarithms, one on heats of formation for chlorides, oxides and hydroxides, and sulphides; various acid and alkali tables, specific heats of elements and various solids; heat equivalents of vaporization; vapor tensions; and hundreds of others. No single handbook will answer every question, but this will answer so large a number as to save many a long hunt through voluminous textbooks.

Company Reports

UTAH METAL & TUNNEL COMPANY

The second annual report of the Utah Metal & Tunnel Company shows the following:

Gross value of ore mined	$1,499,267.69
Income from rents, water, etc.	35,946.62
	$1,535,214.31
Expenses:	
Smelting and refining charges	$377,304.58
Mining	247,907.36
Development	148,713.08
Hauling	7,251.36
Lease ore	26,411.07
Milling	67,528.31
Selling, administration, and general expense	58,267.94
	$933,383.70
Operating profit	601,830.61
Interest and discount earned	18,102.65
	$619,933.26
Taxes	19,851.90
Interest on bonds	15,245.88
	$35,097.48
Net profit less depletion	584,835.48
Depletion charge	56,098.16
Profit	$528,737.32

THE CANADA COPPER CORPORATION (LTD.)

The annual report of the Canada Copper Corporation, Limited, for the year ended December 31, 1916, contains the following:

From the Greenwood, B. C., property a net profit of $215,304.85 was made after deducting depreciation to the amount of $235,238.37.

The total ore smelted during the year was 306,450 dry tons, of which 23,243 tons was custom ore. This ore produced 5,196,239 lb. of copper, 49,928.71 oz. silver, and 12,366.24 oz. gold.

The Mother Lode mine supplied 256,784 tons of ore, averaging 0.945% copper, 0.034 oz. gold, 0.160 oz. silver. It was only possible to operate the smelter because of the high price of copper. High cost of operating was due to the ore being taken from pillars and caved areas remaining in the mine, and to the high cost of labor and supplies. Smelting operations were much interferred with, due to a continuous shortage of coke.

The Copper Mountain property was provided with a power-transmission line 13.6 miles long, and compressor, machine, blacksmith, and carpenter-shops were provided. Also warehouses, bunk-houses and additional dwellings, as well as other necessary improvements. A 50-ton flotation-mill was built and operated throughout the year.

An adit 9 by 9 ft. was driven 2100 ft. The total of driving, raising and lateral drifts being 5200 ft. Over 8000 ft. of diamond-drilling was done, and 2364 ft. of surface trenching was performed. During the year $396,000 was expended in the equipment and development of this property.

It is estimated that the ore reserves of the Copper Mountain contain 10,000,000 tons definitely assured and 2,000,000 tons of probable ore. The average grade of this tonnage is 1.74% copper and 20c. per ton of recoverable gold and silver.

The company holds a large area of property that is only partly developed; that on Kennedy Mountain having been superficially prospected by means of 1777 ft. of diamond-drilling and 956 ft. of adits.

The company is negotiating with the railroad company for the early construction of a branch from Princeton to Copper Mountain, 13 miles. Arrangements are also being made for additional power, and for the disposal of the concentrate produced in the mill.

Mining Decisions

Mining Option—Optionee Not Bound

Entrance on the property for the purpose of prospecting the same by the holder of an option covering mining ground does not constitute a taking up of the option to which the optionee could be held, even though the option provided for an "acceptance" by the optionee prior to making payments.

Johnson *v.* Clark (California), 163 Pacific 1004. March 13, 1917.

Coal Lease—Minimum Royalties

Under a mining lease providing for minimum royalties, the lessor may recover the same whether any coal was mined or not, upon failure of the lessee to surrender the lease before the royalties became payable.

Saylor Park Land Co. *v.* Glenwood Coal Co. (Iowa), 162 Northwestern, 203. April 5, 1917.

Miners Liens—Borrowed Machinery Subject to

Partners lending donkey engines to a mining company which were subsequently used by miners employed by that company with the full knowledge and acquiescence of the partners, are estopped from defending against mechanics liens placed thereon by the miners.

Rogers *v.* Reynolds (Washington), 164 Pacific, 80. April 3, 1917.

Abandoned Oil Lease—Removal of Machinery

Eight months is a reasonable time within which an oil lessee may remove pipe left in the ground upon abandoning his lease, where the lease gave the lessee the right to remove all machinery, fixtures, and improvements at any time.

Standard Oil Company of Louisiana *v.* Barlow *et al.* Louisiana), 74 Southern, 627. March 12, 1917.

Marking Boundaries—Attitude of Courts

Acquiring certain antimony mining locations in 1906, 1907, and 1908, appellant thereafter expended some $25,000 in developing the property, installing mining equipment, digging water ditches, constructing roads, tunnels, cross-cuts, and other workings, and doing the annual assessment work each year until 1914. In April 1915, respondent, who had assisted in performing the assessment work on the claims in 1913 and was thoroughly familiar with their boundaries and extent, went on the ground and located it as vacant and unoccupied government land. Held, that no title was acquired by respondent. Being familiar with the boundaries and extent of the claims, he cannot be heard to claim an insufficient marking of boundaries, and having located it as "vacant and unoccupied government land," he cannot base his title on a re-location of forfeited ground. The courts express a liberal policy in the matter of adjudging compliance with the statutes requiring marking of boundaries by those who have spent time and money in good faith in the development of mineral ground.

Gold Creek Antimony Mines & Smelting Co. *v.* Perry (Washington), 162 Pacific, 996. February 13, 1917.

INDUSTRIAL PROGRESS

Auxiliary Engines for Hoists

The auxiliary engines of a hoist are the giant hands which operate the brakes, clutches, and reverse. Large hoists with massive parts requiring delicate movement, would have been impossible were it not for the development of auxiliary thrust-engines. An analogy is found in the air-brake on long trains of freight cars, multiple unit-control of traction-motors on electric trains, and similar examples.

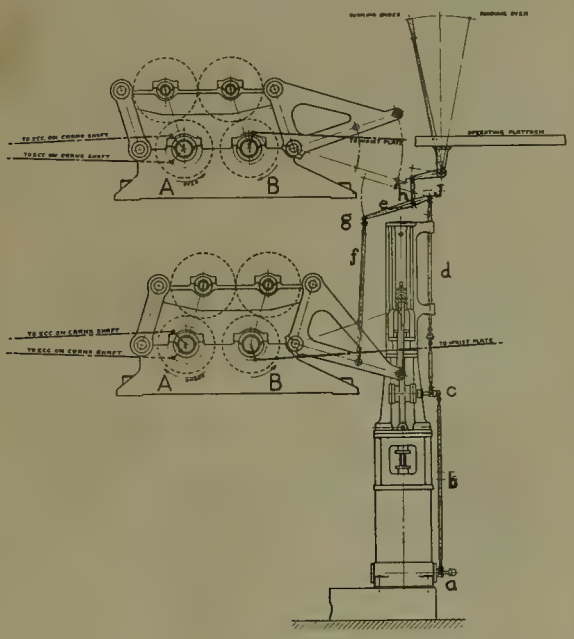


FIG. 1

There are three types of thrust-engines for hoists—steam, air, and hydraulic, or oil-operated.

Steam-thrust cylinders are used in the case of small and moderate-size non-condensing engines. On high-efficiency compound-condensing hoists, the more economical hydraulic type is always used. This is a matter of consistency, since the steam-thrust cylinders might waste more steam than was saved by operating compound-condensing engines.

Air-operated thrust-engines are used principally in connection with air-hoists. At the Anaconda copper mines, at Butte, the various air-operated hoists are all controlled by air-cylinders. A few electric-hoists also have been fitted with air-operated auxiliary-engines, but hydraulic control is almost universal practice. Hydraulic-control uses a fluid—generally oil, under pressure from an accumulator served by motor-driven pumps. In what follows, the construction and operation of these three types of auxiliary thrust-engines as designed by the Nordberg Manufacturing Co. are described. We are indebted to the manufacturers for the photographs and drawings shown.

STEAM-OPERATED:—The steam-operated thrust-cylinder shown by the drawing of Fig. 1, consists of a vertical steam-cylinder with an oil-cataract cylinder above, and at the top a cross-head guide. It is shown in connection with a four-gear reverse.

All hoisting-engines run in both directions so that the steam distribution when running 'over' or 'under' must be the same. As this cannot be accomplished by any link-motion, this device is used on large Nordberg steam-hoists. This consists of a train of four gears; the two lower gears 'A' and 'B', have their axes fixed on stationary shafts, shaft 'A' being driven by eccentrics on the drum-shaft, shaft 'B' driving the wrist-plate. The

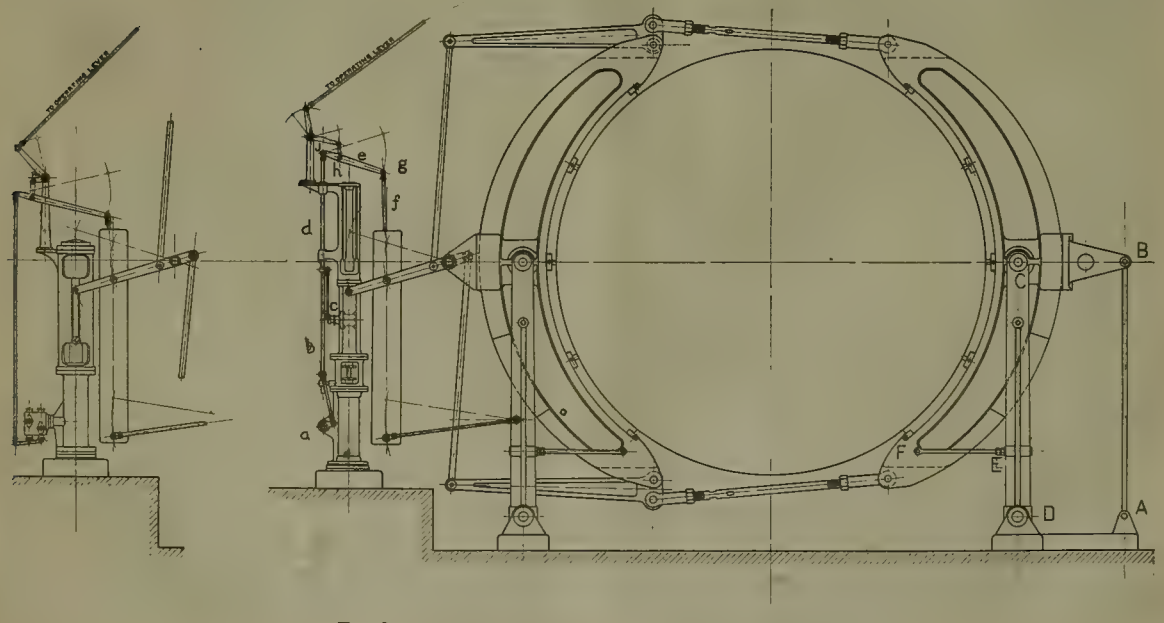


FIG. 2. SHOWING OPERATION OF PARALLEL POST-BRAKES

two upper gears are mounted on a carriage by means of which they are swung through a certain angle by the thrust-cylinder.

At the bottom of the cylinder is a self-draining valve (a) operated by the rod (b), which also operates the oil by-pass or cataract-valve (c). The rod (b) is connected by a rod (d) to a floating-lever (e), whose other end is supported by a rod (f), which is attached to the mechanism moved by the thrust-cylinder, in this case the reverse-carriage.

When the operating lever is shifted to the right the floating-lever (e) is lifted about (g), as a fulcrum, since rod (f) is held stationary. Rod (b) rises, opening the steam-valve (a) and the oil-cataract valve (c). The steam-piston rises and simultaneously lifts the lever (f) and the pin (g). The floating-lever now moves about point (h), as a fulcrum, so that rod (b) moves downward to close the steam-valve (a) and cataract-valve (c). Steam is shut off and the closure of the oil-valve locks the piston in the oil-cylinder. The cross-head has been moved and locked in a position corresponding to the movement of the operating-lever. In other words, the entire mechanism

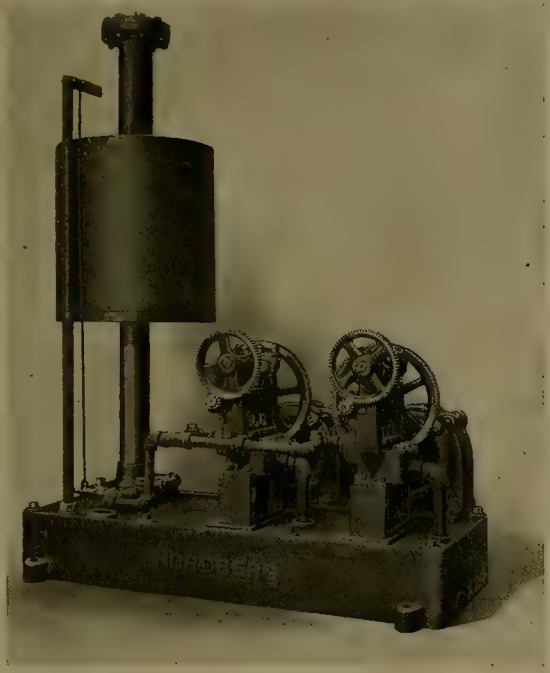


FIG. 3

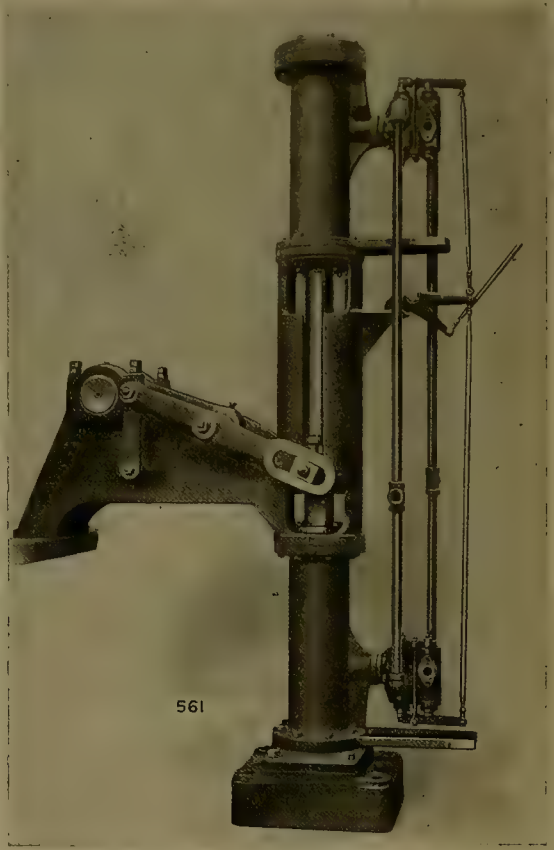


FIG. 4

has followed the movement of the operator's lever and, as soon as he ceases movement, the mechanism has the same control over it as though it were directly operated by hand. Brakes, clutches, reversing-gear and throttles, where necessary, are operated by this device.

AIR OPERATED:—Fig. 2 shows the arrangement of a thrust-cylinder operated with air. In this case the mechanism is shown for operating the gravity post-brake and the floating-lever control allows the operator to apply the brakes with full control of the speed of application and brake pressure.

In the drawing, the ends of the carriers A, B, C, D, form the corners of a parallelogram, such that the brake-post must move in a position parallel to itself. There are two sets of lever and draw-bars for drawing the brakes together, one at the top and one at the bottom, with provision for adjustment.

With this construction the brake-shoes have exactly the same pressure all around, so that there is no uneven wear in pinching which is present in all designs where the brake-posts are hinged at the bottom, or with band-brakes. A small movement only is necessary to have the brake clear equally all around.

This design of brake in connection with the thrust-cylinders with floating-lever control, gives the operator full control of the braking, exactly as though the brakes were operated by hand. He can regulate the speed with which the brakes are applied, or released, and control the brake-pressure with the utmost delicacy.

All thrust-cylinders should be of long stroke so as to get flexible and accurate control. The cataract-cylinder should also be provided with a valve, and not merely a by-pass port, into which a plug is screwed to restrict the passage of oil from one end of the cataract-cylinder to the other. This mechanism has the disadvantages of: (a), limiting the speed of operation, and (b), not serving as a positive lock for the mechanism.

HYDRAULIC OR OIL-OPERATED:—Fig. 3 shows the oil-operated thrust-cylinder at the left, also arranged to operate a gravity-brake. It consists essentially of the same floating-lever control, one end of the floating-lever operating the valves and the other end being attached to the mechanism that is moved, the operator's lever taking hold between these two points. The valve mechanism consists of two valves; one for admitting and the other for discharging the oil and the design is such that it is impossible for both the inlet and discharge-valves to be opened simultaneously. As soon as the motion of the operating-lever is stopped, the floating-lever closes both oil-valves and the piston is positively locked in any position desired by the operator.

For operating clutches, these thrust-cylinders are made double-acting by using two single-acting oil-cylinders, as shown in Fig. 3, and also in connection with the clutch-operating

rocker-arm and shaft in Fig. 4, which shows the electric-hoist at the Elm Orlu mine.

In conjunction with the hydraulic-thrust engines a small motor-driven pump in duplicate, and a pressure-accumulator

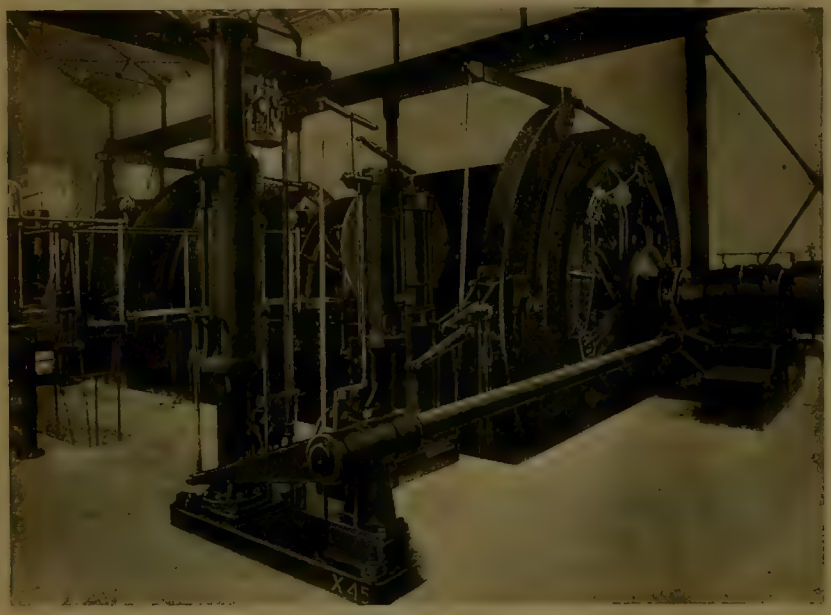


FIG. 5

are installed in a unit, as shown in Fig. 5. This makes the hoist independent of the mine air-supply and dependent entirely on the electrical power. Hydraulic thrust-cylinders are particularly well suited to the application of safety devices to prevent overspeeding and to insure slowing down as the dump is reached, and of reversal before starting.

The Oxy-Acetylene Method of Cutting Metals

For cutting off rivet-heads and stay-bolts flush with plates, by the oxy-acetylene process, it is desirable to have a cutting-tip so designed as to permit of the gas-jet playing parallel with the plates. To meet this need The Prest-O-Lite Co., Inc., of Indianapolis, Indiana, is manufacturing a special Rivet and Stay-bolt Cutting Attachment. This attachment is used in connection with the Type K Cutting Blow-pipe shown, being screwed into the head in place of the regular cutting-nozzles. The copper-tip is bent at a convenient angle and is adjustable to any position, facilitating operation in close quarters. Much cleaner work in rivet and stay-bolt cutting is possible with this attachment than with standard cutting-tips which do not permit of a cut that is truly parallel with the plates.

The Prest-O-Lite Co. has issued a new catalogue descriptive of the apparatus and methods of welding and cutting metals by means of the application of the oxy-acetylene flame. This outfit is of great service and value to mine equipment, and particularly to mines situated at a distance from towns where foundries and machine-shops are always available. The catalogue will be sent on application to the Prest-O-Lite Co. at Indianapolis, Indiana.

A New Publication

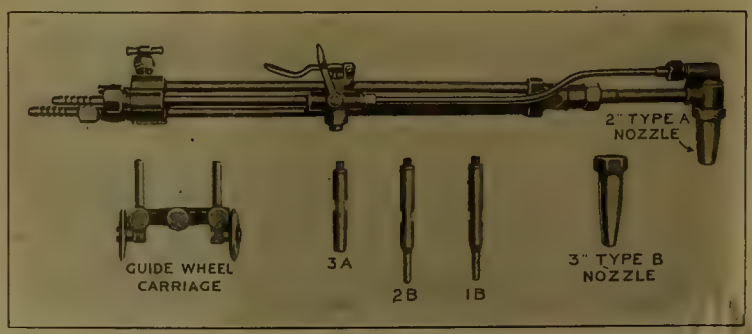
Water works pumping-plants have recently undergone a rapid and radical evolution. The tremendously heavy and expensive, although efficient, triple-expansion pumping-engine has given place to the more compact, simple and less costly steam-turbine-driven centrifugal pump. The efficiency of the latter has risen steadily with the experience of its builders and with improvements in auxiliary equipment, until duties under standard steam conditions exceeding 150,000,000 ft.-lb. per 1000 lb. of steam are now obtained. The De Laval Steam Turbine Co., of Trenton, New Jersey, builder of the largest pumps of this type, has just issued, under the title 'progress in Water Works Pumps,' a 48-page booklet discussing the general, economic, and engineering conditions affecting the design and installation of such pumps. Installations in 15 of the principal cities of this country and Canada are described, including 34 units aggregating 999,000,000 gal. per day capacity. The publication should be of value to any one interested in the handling of water.

The Janney Flotation-Test Machine

The Stimpson Equipment Co. of Salt Lake City has issued a pamphlet descriptive of the Janney flotation-test machine which cannot fail to interest every flotation-operator in the country. The book is fully illustrated with half-tones and line drawings which scarcely require explanation. All who want to test the amenability of their ores to flotation should send for this latest contribution to the literature on flotation.

G. E. LAND has been appointed advertising manager for the Blaw Steel Construction Co. at Pittsburg, Pennsylvania.

RIVET-CUTTING ATTACHMENT



THE PREST-O-LITE CUTTING BLOW-PIPE